THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 40. Thursday, May 2, 1929. No. 663.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

Contents.

	PAGE
Forthcoming Events	317
Seeking a Solution	317
An Educational Exhibit	317
The International Test Bar for Cast Iron	318
Foundry Congress Visitors	319
The Copper Situation	319
Future of the Wrought-Iron Trade	319
Reports and Dividends	319
Random Shots	319
International Foundry Congress	320, 322
Life of Ingot Moulds	321
Book Review	321
Some Interesting Moulding Jobs	322
Monel Metal	323
The System Magnesium-Zinc	326
The Change of the Total Carbon of Cast Iron during Melting	327
The Quest for Markets	328
Physical Properties of Foundry Coke	329
The Balance-Sheet	330
Ironfounding Workers' Union	330
Production of Iron and Steel	330
Imperial Chemical Industries, Limited	330
Trade Talk	332
Personal	332
Obituary	332
Contracts Open	332
Iron and Steel Markets	334

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Telephone: Central 1895. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332)*

Forthcoming Events.

MAY 7.

Institute of Metals:—Nineteenth May Lecture in London. "Some Ideas about Metals." Paper by Sir Oliver Lodge, F.R.S., LL.D.

MAY 14.

North-East Coast Exhibition at Newcastle-on-Tyne.

JUNE 5-15.

International Foundry Trades Exhibition, Royal Agricultural Hall, London.

Institute of British Foundrymen.

MAY 4.

Lancashire Branch:—Ordinary meeting at Manchester. "Some Practical Hints in Non-Ferrous Casting," Paper by A. Hapwood.

Seeking a Solution.

We would draw attention to the correspondence, printed elsewhere in this issue, on the subject of the creation of an internationally-accepted arbitration bar to be used in connection with grey-iron castings. It is only too apparent that the question is becoming chaotic, and it is to be hoped that the London Congress will clear the air.

There is something to be said in favour of the original resolutions passed at the Paris Congress and, with the passage of time, the thought then expressed that the resolution of the problem of testing satisfactorily the metal itself would proceed by a considerable period of time that to be associated with the solving of the problem of the testing of castings themselves. It now appears to us that the national interest can standardise on the British Engineering Standards Association Specification Number 321 for a period of, say, five years. We advisedly postulate a limited period, as we do not favour the imposition of a standard specification to last for all time, as it induces technical stagnation, by the automatic elimination of effort to beat "the other fellow." Rather is effort concentrated on meeting with an adequate margin the conditions imposed.

For the resolution of the problem of the testing of actual castings, it can be stated immediately that no test will ever be evolved which apply to every type of grey-iron casting, because each type represents a different industrial application. Even if X-ray examination became as common as visual inspection, still it would give no indication of wearing properties. Narrowing the subject to that of ascertaining the mechanical properties of the metal forming part of a casting destined to be used in engineering practice, the following may be taken to represent the existing position:—(1) Engineers detesting the visualisation of new standards, prefer that any proposed test should be convertible into terms of tensile strength and a very limited number of other tests. (2) Whilst true mathematical relationship can rarely be established, some obviously "check-up" better than others. British foundry executives and research workers, after many trials, feel themselves justified in stating that the shear test as proposed by French authorities is unreliable, viewed from no matter what angle. Before any attempt is made to test castings as castings, it would seem desirable materially to narrow the issue, so as to define in the clearest possible manner the object in view. If it is merely an appraisal of the metal in the castings, then separately-cast bars designed so as to imitate the thermal history, as has been attempted by the British Committee will surely serve.

An Educational Exhibit.

We drew attention in a recent issue to the arrangements in progress for a technical exhibit at the International Foundry Exhibition that is to take place in London next month. We understand that an educational exhibit is also contemplated. It would be no exaggeration to say that progressive leaders in the industry are looking to foundry education and training for an ultimate solution to their more pressing problems. What is more, practically every solution of a more immediate nature that is put forward calls for a better educated personnel, which the founders must train for themselves.

Two offers of educational material for the exhibit in question have already been received, and the exhibit, like the Exhibition proper, is to be international in character. While space will not be available for actual exhibits of work done or models made by students, there is a warm welcome awaiting material that relates to schemes of training, syllabi, methods in use, and so forth, whether from Universities, from technical colleges and institutions, or from works in which training schemes or apprentice courses are in progress. The aim is to cover both the education and the training of the craftsman and of the foundry metallurgist, engineer, or manager.

It is scarcely to be hoped that this will be read by all who are likely to be interested in the various educational institutions concerned, and we therefore hope that our friends in the industry will bring the matter to the notice of local authorities and others concerned. The Exhibition authorities will provide the space and look after the insurance and safeguarding of the exhibits, so that the only cost involved is that of the transport to London.

The results which are hoped for must be achieved not by corporate but by individual action. We referred in our previous note to the Düsseldorf Exhibition in connection with the technical exhibit. There was on the same occasion a remarkable educational section, very largely organised by the German "Datsch" (Deutscher Ausschusz für Technisches Schulwesen, or German Association for Technical Instruction). This is an association promoted by the great employers' associations to foster studies in technical schools. It is able to facilitate teaching in a very useful way by the issue of text books and charts, and some fine illustrations of these were available at the exhibition. Suggestions for material for the exhibit will be welcomed at this office, and will be transmitted to the Committee concerned.

XUM

The International Test Bar for Cast Iron.

Situation Becoming Involved.

Below we publish two letters on the above subject, the first being a letter from M. Ronceray, the honorary secretary of Foundrymen's International Arbitration Bar Committee, to Mr. Makemson, secretary of the Institute of British Foundrymen, which discloses the attitude adopted by our French colleagues. The second is a commentary on the situation from Mr. John Shaw, and can be taken as representative of the British point of view. Translated, M. Ronceray's letter reads:—

Dear Mr. Makemson,—I have received your letter of February 13.* I have sent the translation to the persons interested; that is to say, the President of our French Commission on Testing Iron, and the President of the Association Technique de Fonderie.

The President of the International Commission on Testing Iron, Mr. Albert Portevin, asks me to reply to you as follows:—

(1) Any decision which the International Commission may come to must necessarily have now for a starting point the *resolution unanimously passed* of the Paris Congress of Foundrymen, whereby the existence of two separate problems was expressly acknowledged, viz., the testing of the cast iron as a metal, as distinct from that of the castings, and the testing of the machine test pieces obtained direct from iron castings.

(2) As regards the first problem, the French Committee may, if they think fit, adopt the suggestion of the British Committee by choosing, as a basis for a discussion, the specification No. 321 for the testing of cast iron *per se* as distinct from that of the castings.

But in reference to the second problem the French Committee has already expressed their opinion, and it seems to me that this time the starting point to be selected could be the last-published statement in the matter, that is to say, that which was submitted to the International Congress for the Testing of Materials (Amsterdam, 1927). As, moreover, this statement has been heard by an International Congress, I consider it as the best for broaching the discussion. Still, the committee of the Technical Association of Foundrymen do not realise the necessity in a purely technical matter for the number of members to be proportional to the importance of the Associations. Scientific questions bear no relation to the size of membership.

The president of the French Committee, M. Le Thomas, Ingenieur du Genie Maritime et Directeur des Fonderies Piat à Soissons, has requested me to ask you to give up the idea of summoning a predetermined number of delegates, but merely to ask the President of each of the Associations of the various countries to suggest the names of the most competent members. It should, moreover, be possible to reduce the number of delegations, which might be otherwise too numerous, but the question of the numerial importance of the size of the membership in the various associations should not be brought in, as it has nothing to do with this scientific debate.

At any rate, we decline to take, as a basis for the discussion, the specification No. 321 of the B.E.S.A., for the latter would result in eliminating *a priori* the examination of the Frèmont methods, unless it be understood, as Mr. Portevin stated, that this specification can refer only to the testing of cast iron, *per se*, as distinct from that of the castings.

The Committee of the Association at their meeting yesterday is entirely in accord with this point of view.

I shall be very much obliged if you will forward me your opinion so that I can discuss it with the President of the International Commission, Mr. Portevin, before sending out the agenda for the meeting to be held during the London Conference.—Yours, etc.,

E. Ronceray.

Mr. Shaw, who has had the opportunity as Convenor of the I.B.F. Test Bar Committee, deems it desirable that the following statement should be widely known and appreciated. His letter reads:—

Foundrymen's International Arbitration Bar Committee.

Sir,—At the present time the history of the formation of the above Committee seems desirable. At the first International Foundrymen's Convention, held in Paris in September, 1923, two papers dealing with the testing of cast iron were read. After the first one by Prof. Portevin the following resolutions were carried:—

1*st Resolution*: That the International Congress of Foundrymen assembled in Paris *recommends* that in the testing of cast iron the testing of the iron entering the castings be differentiated from the testing of the quality of the castings themselves.

Be it further resolved that immediate steps be taken to study both branches of the problem side by side, with the expectation that the problem of testing the quality of the iron will be resolved earlier than that of testing the castings themselves. It is recognised *that in no case* will the testing of the quality of the iron give reliable information as to the quality of the castings made from it.

Be it further resolved that a Joint Committee be appointed from the nations represented in Paris to make suitable recommendations for carrying this proposal into effect.

These resolutions, which bear the impress of three or four interested parties, did not appear on the agenda. No opportunity was given for consideration or consultation with the Association's officials, and the whole situation was dominated by the 1,000 French members present. A catch vote of this type is futile. It would be just as easy at the forthcoming London Convention to repeal these resolutions, and pass at once that the B.E.S.A. specification No. 321 be adopted as the International standard, and the result would be the same unless agreement sustained by proved results under every condition can be obtained, no progress will be made.

During the river excursion to St. Germains a further meeting was held to discuss the nature of the International Arbitration Bar for cast iron. It was decided that each country should put forward its own recommendations, *without criticisms of other countries proposals*, but with a full explanation of the advantages to be associated with their own.

The reports to be sent to Messrs. Portevin and Ronceray, who kindly consented to act as a "clearing house," and to forward copies of each report as received to every Association concerned. The writer was appointed British representative, and has kept M. Ronceray in touch with each stage in the development of the I.B.F. specification. The tentative and the complete specification as accepted by the B.E.S.A. in their No. 321 being sent as issued. No member of the I.B.F. Committee has at any time attacked the "Frèmont" test except in discussion of the propaganda papers on the subject. It is true that recently some figures obtained by this method have been published,* but their sole object was to afford M. Le Thomas an opportunity to reply to these in his paper at the London Convention. So far the writer has, during the five years, received no figures or copies of reports from M. Ronceray from other countries. Are we to gather from this that no other country has sent reports, or has the "clearing house" ceased to function? We are at the moment in complete ignorance of any report other than those published in the technical Press.

At the second International meeting, held in Detroit in 1926, for some reason no meeting of the International Committee was held, although each nation was represented. Through the courtesy of the A.F.A. Test Bar Committee M. Ronceray and the writer was invited to be present at their meeting, at which the reports from Elliot and Rother on the results they obtained on the "Frèmont" machine were discussed. It was at this meeting that M. Ronceray, owing to certain criticism, suggested that the principle of the "shear" test, as apart from the particular method, be investigated.

Early in 1927 the I.B.F., having completed its work on B.E.S.A. No. 321, turned its attention to the shear test. Full-size blue prints of the machine adopted in America were issued to various members of the Committee, with a request that they try out the test under works conditions, making comparisons with either tensile or transverse bars cast from the same ladle. Their task was simplified by some excellent work carried out on these lines for some time by B.C.I.R.A. and Jolley. It soon became evident that no constant ratio between shear and tensile or transverse existed. This led (at the Birmingham meeting held January 19, 1929) to three resolutions being submitted to the full General Council, who after passing them gave the Secretary instructions to forward to M. Ronceray for distribution to the nations concerned, and whose representatives formed the original panel. The resolutions were:—

(1) That M. Ronceray, in his capacity of liaison officer, be requested to call a meeting of the International Test Bar Committee, to be held in London during the Convention in June.

(2) It is suggested, that in order to place the Committee on a fair and working basis, each Association appoint a delegate. Any Association with a membership of over 500 can appoint a further delegate for every complete 500 members after the first 500. This would enable the smaller Associations to be represented, while the larger Associations, whose interests would be more vitally affected, would receive a proportional representation in relation to their importance.

(3) It is suggested that the B.E.S.A. specification No. 321 be also put forward as a basis for discussion as the International specification.

It will be seen at once that the I.B.F. in putting forward item No. 2 have no wish to dominate the situation and repeat the mistake made at Paris. A clear four months' notice has been given. It affords time for all Associations concerned to consider their policy and instruct their delegates accordingly. That numerically the I.B.F. will be in a weaker position than America, and probably than France, that small Associations with a low membership will have a delegate to express their views and vote.

After waiting for over two months for a reply we learn that instead of our requests being put before the Associations for consideration they have only been submitted to the French Committee. While this Committee is an important one, it is only one, and any final decision must come from the delegates of the whole of the Associations concerned. Any suggestion even from the smallest Association must be placed on the agenda and discussed, if any true progress is to be made.

Any further delay, as the time is now so short, will make it impossible for the points raised to be considered by the various Associations concerned: hence this letter.

* The official resolutions contained in this letter appeared in our issue of January 24, page 78.

* Jolley, Foundry Trade Journal, April 4 and 11, and the writer

The position of the I.B.F. Committee is clear. They are at any time prepared to scrap their ten years' work, as contained in B.E.S.A. No. 321, if any test can be put forward that will yield more information to the inspecting engineer and foundryman. The test must be simple and reliable under all conditions, and yield a result that can be converted into tons per sq. in. tensile (or the like) by a single constant. A visiting inspector for much work relies alone on this simple test to prove the quality of the metal. No test will prove the casting a good one, but a full trial under working conditions. Our experience with the shear test has shown that no one constant is possible. No investigator has yet, on any one machine even, proved a constant ratio between tensile and shear with varying composition of metal.—Yours, etc.,

J. SHAW.

Foundry Congress Visitors.

Additional American Bookings.

Mr. Wm. W. Paulson and Mrs. Paulson (Thos. Paulson & Son, Inc., Brooklyn, N.Y.); Mr. Wm. J. Grede and Mrs. Grede (Liberty Foundry, Inc., Wauwatosa, Milwaukee, Wis.); Mr. E. M. Cabaniss and Mr. J. S. Law (Jos. Dixon Crucible Company, Jersey City, N.J.); Mr. R. E. Kennedy (Technical Secretary, American Foundrymen's Association, Chicago, Ill.); Mr. Jas. T. MacKenzie (American Cast Iron Pipe Company, Birmingham, Ala.); Mr. M. J. Evans and Mrs. Evans (Whiting Corporation, Harvey, Ill.); Mr. Robert Crawford, Mrs. Crawford and Miss Crawford (Atlas Foundry Company, Detroit, Mich.); Mr. R. W. McIlvaine and Mrs. McIlvaine (R. W. McIlvaine Company, Chicago, Ill.); Mr. Edward Frohman (S. Obermayer Company, Pittsburgh, Pa.); Mr. Herbert Weaver (Canadian Foundry Supplies, Limited, Montreal, Canada); Mr. Wm. H. Nicholls (Wm. H. Nicholls Company, Inc., Brooklyn, N.Y.); Mr. Robert J. Turnbull (Arcade Manufacturing Company, Freeport, Ill.); Mr. John C. Pangborn (Pangborn Corporation, Hagerstown, Md.); Mr. Frank Dodge and Mrs. Dodge (Werner G. Smith Company, Detroit, Mich.); Mr. H. B. Hanley and Mrs. Hanley (Rochester, N.Y.); Mr. W. B. Willard (Grand Rapids, Mich.); Mrs. Kirk (with Mr. and Mrs. Utley); Mr. F. R. Ringle, and Mr. Thomas Kaveny, Jr. (Herman Pneumatic Machine Co., Pittsburgh, Pa.).

The Copper Position.

Copper Exporters, Incorporated, the American organisation which was formed some two years ago and includes the leading copper producers, has issued a statement designed to increase confidence in the copper market. The price of copper, after a considerable rise over some months to nearly £100 per ton, recently fell sharply. The statement gives the following figures of refined production:—First quarter, 1928, 125,500 net tons per month; second quarter, 127,700 tons; third quarter, 138,500 tons; fourth quarter, 150,800 tons; January and February, 1929, 153,000 tons per month. Average monthly shipments are stated as follow:—First qnarter, 1928, 128,200 tons; second quarter, 137,200 tons; third quarter, 141,000 tons; fourth quarter, 146,300 tons; January and February, 1929, 158,000 tons. It will be seen that the 1929 production figures show an increase of 22 per cent. over the first quarter of 1928, while the shipments show an increase of 23 per cent. The statement points out that, notwithstanding the fact that production was increased as soon as the need could be foreseen, the time required for the product to reach the market resulted in a reduction of refined stocks of 40.000 tons. With all producers at maximum output, the probable demand, it is stated, could have been satisfied had not buyers insisted upon covering their requirements further ahead than necessary. It is stated that the decline in price began in the European speculative market and was augmented by the offering for resale of copper from Europe in the American market.

Future of the Wrought-Iron Trade.

Confidence in the future of the wrought-iron industry was expressed by Colonel J. S. Trinham, a director of Messrs. N. Hingley & Sons, Limited, and of the Harts Hill Iron Company, Limited, at the annual meeting, in Birmingham on Tuesday, of the Midland Iron and Steel Wages Board. Hopes of better trade were, he said, built on more substantial evidence than had been the case in recent years. Costs abroad were steadily rising, bringing Continental prices nearer to British prices, although a very wide gap still existed between so-called wrought iron—a mixture of iron and steel produced under unfair labour conditions—from the Continent and true wrought iron as produced in this country under recognised labour conditions, which made the true wrought-iron trade easily assailable where cheapness without regard to quality was the first consideration. Not only had they to contend with Continental competition, but he was sorry to notice open attacks on their genuine iron products by some steel makers, who contended that by certain additions to their products, or by producing a material to a certain analysis, ingot material would resist corrosion not only as well, but better than wrought iron. The student of metals would need more than this to convince him that any cast ingot material could compete with genuine puddled iron for certain purposes. Wrought iron not only resisted corrosion shocks and fatigue stresses better than any other rolled material, but it gave the most perfect welding results.

Colonel Trinham said he was glad to observe that engineers were now beginning to take notice of the value of good wrought iron, which had stood the test of time. A few months or a year or two of testing one material against another was not sufficient. Length of service was the only proof in the end, and this they had on their side. Steel had done good service and had its special claims, but wrought iron had its proper place in the arts and they must keep that fact before engineers. Worcestershire and Staffordshire were fortunate in still having two furnaces which produced to-day the finest cold-blast iron the world had ever produced, and this enabled them to make the very highest grade of wrought iron that engineers could require. They had makers confident in the future of the wrought-iron trade who were determined it should be kept alive and should some day, soon they hoped, return to some measure of its former prosperity.

French Foundrymen's Association.

New President Elected.

Mr. A. Damour has been appointed president of the Association Technique de Fonderie, in the place of Mr. Thomas, who has now completed two years of office.

Mr. Damour is chairman and managing director of the Société des Fonderies de Bayard and Saint Dizier, and also figures on the directorate of some six other metallurgical concerns.

Reports and Dividends.

Industrial Steels, Limited.—Net profit, £850; brought in, £1,984; to bank loan redemption fund, £2,500; carried forward, £334.

Howard & Bullough, Limited.—Profit, £71,446; brought in, £66,021; ordinary dividend of 8¾ per cent.; carried forward, £3,093.

United Flexible Metallic Tubing Company, Limited.—Profit, £13,238; dividend of 6 per cent., less tax; carried forward, £9,129.

Robert Stephenson & Company, Limited.—Profit, £11,147; brought in, £17,175; dividend of 5 per cent., less tax; carried forward, £17,323.

Baldwins, Limited.—Profit for 1928, £220,107; depreciation, £79,131; special expenditure at collieries, £12,250; income-tax, £9,160; debenture interest, £95,549; bank interest, £6,787; carried forward, £3,399.

Steel Company of Canada, Limited.—Profit for 1928, $4,506,482; to bond sinking fund reserve, $314,319; to depreciation account, $1,079,240; bond interest, $329,527; preference share dividend, $519,704; ordinary dividend, $920,000; pension fund, $100,000; employees' benefit fund, $100,000; surplus, $1,143,691.

Random Shots.

Quite the most interesting of the speakers at the recent dinner of the National Federation of Iron and Steel Manufacturers was Mr. John Hodge, for he was simple, direct, and human. By way of contrast, Lord Hailsham was essentially the orator, while the Minister of Transport seemed distinctly unhappy in his task.

* * *

Mr. Hodge told a story which is not likely to figure in the more formal accounts of the evening. A hungry man went into an eating-house for a meal, and after waiting vainly for some time for attention, decided to leave. The proprietor stopped him at the door and wanted to charge him fourpence on the ground that he had been satisfied by the smells. A passer-by was called in to arbitrate. When he had heard both sides, he called for fourpence from the customer and a basin from the proprietor, then, ringing the coins in the basin, he pronounced that since the customer had to be satisfied with the smell of the food the proprietor must be satisfied with the sound of the money.

* * *

I cannot for the moment recall the connection in which Mr. Hodge told the story, but perhaps that hardly matters, for I have heard him tell it before. Doubtless the arbitrator retained the fourpence in payment for his services!

* * *

It will be exceedingly interesting to learn what our American visitors this summer will think of us. How instructive it would be if we could establish a kind of national visitors' book, in the best boarding-house manner, wherein travellers from abroad might record their outstanding impressions. And by this I do not mean their official and public impressions of our industries, our political organisation, and so forth; these are already available quite often enough. I mean rather their unofficial and private impressions of our homes and our manners and our way of life. In this connection I cannot but recall some of my own impressions of Canada and the States, gleaned during a visit more years ago than I care to remember. Like most Englishmen I was struck by the absence of garden fences; it sounds a trivial thing enough, but try to visualise an English suburb bereft of its hedges and palings, and you will realise how striking the difference is. I can heartily endorse the common view that domestic engineering there is vastly ahead of ours; kitchen and bathroom accommodation and fittings are in an altogether different class.

* * *

THE DIALOGUES OF ALBERT THE FOUNDRY FOREMAN.

ALBERT AND THE GENERAL ELECTION.

The Canvasser: "Well, Albert, and I hope you'll be going to the polls this month, as every true-born Briton should?"

Albert: "Well, I don't 'old with this 'ere voting business."

The Canvasser: "But surely you are interested in the Government of your country?"

Albert: "Too much o' this 'ere Government, that's what I ses."

The Canvasser: "Ah, but think how important it is——"

Albert: "Not to my way o' thinking, it isn't. All I asks is a regular wage that'll keep the missus happy, an' a half-day Saturday for the Cup Tie or the Dawgs, an' a drop o' beer and a cosy pipe, an' that's enough."

The Canvasser: "Ah, but my candidate stands for much more than that."

Albert: "Much more? I daresay. It ain't the more I'm interested in, it's *that*. If you can show me a candidate as'll guarantee that, 'e gets my vote, an' if you can't—I've a job o' work to be gettin' on with, *if* you'll excuse me!"

MARKSMAN.

International Foundry Congress

AND

Twenty-sixth Annual Convention of the Institute, London, June 10, 11, 12, 13 and 14, 1929

The 26th Annual Convention of the Institute will be held in London from June 10 to June 14, 1929. This Convention will be of an unusually important character, in that it will also form the third of the series of triennial International Foundry Congresses, the first of which was held in Paris in 1923, the second in Detroit in 1926.

The railway companies, except the Metropolitan, Metropolitan District and London Electric Railways, have agreed to issue tickets at the ordinary single fare and one-third for the double journey, fractions reckoned 3d., upon surrender at the time of booking of vouchers, to be obtained from the General Secretary. These tickets will be issued from June 8 and are available for return up to June 17. It is expected that this Congress will be an unusually large one owing to the presence of a large number of foreign delegates.

The International Foundry Trades Exhibition

The International Foundry Trades Exhibition will be held at the Royal Agricultural Hall, London, N.1, from June 5 to June 15. The Exhibition is organised by Messrs. F. W. Bridges & Sons, Limited, and is held under the patronage and with the active co-operation of the Institute of British Foundrymen and the Foundry Trades Equipment and Supplies Association, Limited. The Technical Section of the Exhibition is being organised by the Universities and Research Associations of Great Britain, and the Exhibition will portray the current scientific and research work which is being done in the country and its practical application to the Foundry Trade.

Programme.

MONDAY, JUNE 10.

6.0 p.m.—General Council Meeting at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1. Nearest Underground Stations—St. James's Park and Westminster.

8.0 p.m.—Annual General Meeting of the Institute, open to all Members, Associate Members and Associates, at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, Westminster, S.W.1.

TUESDAY, JUNE 11.

10.0 a.m.—Congress commences in the Grand Council Chamber of the Guildhall of the City of London. Nearest Tube Stations—Bank, Moorgate and Mansion House.

Official welcome by the Rt. Hon. the Lord Mayor of London (Sir Kynaston Studd, O.B.E.).

11.0 a.m.—Presidential Address (Mr. Wesley Lambert).

Presentation and Discussion of Papers.

12.30 p.m.—Conference adjourns.

Afternoon.—Optional visit to works of Messrs. Fraser & Chalmers' Engineering Works (Proprietors, The General Electric Company, Limited), Erith, Kent; Messrs. Dewrance & Company, 165, Great Dover Street, S.E.1; The United Glass Bottle Manufacturers, Limited, Charlton.

4.30 p.m.—Reception at the Guildhall by kind invitation of Sir John Dewrance, K.B.E. All Members, Delegates, and Ladies are invited.

Evening free.

WEDNESDAY, JUNE 12.

9.30 a.m.—Congress continued at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1.

Presentation and Discussion of Papers.

12.30 p.m.—Congress adjourns.

Afternoon.—Members and Delegates' optional visit to works of Messrs. Kryn & Lahy (1928), Limited, Letchworth, Herts; Messrs. J. & E. Hall, Limited, Dartford Ironworks, Kent; Messrs. Lake & Elliott, Limited, Braintree, Essex.

6.30 for 7.0 p.m.—Annual Banquet at the Hotel Cecil, Strand, W.C.2, for Members, Delegates and Ladies. Nearest Tube Stations to Hotel Cecil—Trafalgar Square, Charing Cross and Strand.

THURSDAY, JUNE 13.

9.30 a.m.—Congress continued at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1.

Presentation and Discussion of Papers.

12.0 noon.—Conference adjourns.

1 for 1.15 p.m.—Luncheon to Overseas Delegates at the International Foundry Exhibition, Royal Agricultural Hall, Islington, N.1, by kind invitation of the Organisers, Messrs. F. W. Bridges & Sons, Limited.

2.30 p.m.—Official Visit to the International Foundry Trades' Exhibition, Royal Agricultural Hall, Islington, N.1.

4.30 p.m.—Tea to all Members of the Institute and Delegates at the International Foundry Exhibition, by kind invitation of Messrs. F. W. Bridges & Sons, Limited.

8.0 p.m. to 12 midnight.—Dance and Cabaret at the New Burlington Galleries, Burlington Gardens, W.1, by invitation of the Conference Committee and the Foundry Trades' Equipment and Supply Association, Limited. Nearest Tube Station—Dover Street (Central London Railway).

FRIDAY, JUNE 14.

10.0 a.m.—Excursion to Canterbury. Members, Delegates and Ladies. Motor coaches leave Embankment. Lunch at the "Tudor House," Bearstead, Kent.

4.0 p.m.—Leave Canterbury for return journey and tea at the "Tudor House," Bearstead, Kent.

Fare, including lunch and tea, 10s. 6d. each person.

Ladies' Programme.

TUESDAY, JUNE 11.

4.30 p.m.—Reception at the Guildhall, by kind invitation of Sir John Dewrance, K.B.E. All Members, Delegates and Ladies are invited.

WEDNESDAY, JUNE 12.

6.30 for 7.0 p.m.—Annual Banquet at the Hotel Cecil, Strand, W.C.2, for Members, Delegates and Ladies.

THURSDAY, JUNE 13.

8.0 p.m.—Dance and Cabaret at the New Burlington Galleries. Nearest Tube Station—Dover Street (Central London Railway).

FRIDAY, JUNE 14.

10.0 a.m.—Excursion to Canterbury.

Every lady attending the Conference will receive a book containing various coupons admitting the holders to visit popular places of interest in London.

Papers to be Presented.

1.—*American Exchange Paper.* "Some Inter-Relationships in Grey Iron Metallurgy," by J. W. Bolton.

2.—"The Desulphurisation of Iron and Steel." Presented on behalf of the Polish Foundrymen, by K. Gierdziejewski.

3.—*French Exchange Paper.* "Cast Iron Testing Methods," by M. Le Thomas.

4.—"Testing in Relation to the Design of Castings," by J. G. Pearce, M.Sc. (Eng.), (Member).

5.—"The Influence of Chromium in Cast Iron," by J. W. Donaldson, D.Sc. (Associate Member).

6.—"Influence of Manganese in Cast Iron," by A. L. Norbury, D.Sc. (Member).

7.—"The Practical Application of Nickel in Cast Iron," by A. B. Everest, Ph.D. (Associate Member).

8.—"Practical Points from the Metallurgy of Cast Bronzes," by H. C. Dews (Member).

9.—"Die Castings," by A. H. Munday (Member).

10.—*Belgian Exchange Paper.* "Staffing for the Foundry Industry."

11.—"The Problem of Foundry Moulding-Sand," by H. Van Aarst. (Presented on behalf of the Dutch Foundry Technical Association.)

12.—"Coal-Dust as applied to Moulding-Sands," by B. Hird (Member).

13.—"The Application of Pulverised Fuel," by H. W. Hollands and E. Lowndes.

14.—"Steel Castings," by R. H. Greaves, D.Sc. (Member).

Hotel Accommodation. — A circular giving particulars of hotel accommodation in London has been arranged by Messrs. Thomas Cook & Son, official travel agents to the Congress. All Delegates and Members are recommended to reserve their accommodation through Messrs. Thos. Cook & Son, who will also quote for other grades of hotels not specified in the enclosed list.

Registration.—Members and Ladies attending the Convention will receive, per post, prior to reaching London, a Registration Card, bearing the Member's Registration Number. This Card should be exchanged as soon after arrival as possible at the Convention office for an envelope containing tickets requisite for the various functions and visits.

Members who desire to have their tickets, papers, etc., forwarded to them in advance, before the Convention, may obtain same by enclosing an additional 6d. per person with their remittance to the General Secretary.

Souvenir Booklet and Badge.—A Souvenir Booklet giving details of the programme and descriptive of the Convention generally will be issued to each Member and Lady attending the Convention. Each Member and Lady will also receive a Badge.

Conference Offices and Information Bureaux.—Offices will be open as shown below for the issue of tickets, booklets, etc., and for general information:—

Monday, June 10, 5 p.m. to 8 p.m.—The Institution of Mechanical Engineers.

Tuesday, June 11, 10 a.m. to 12 noon.—The Guildhall.

Tuesday, June 11, 2.30 p.m. to 4.30 p.m.—The International Foundry Exhibition, Agricultural Hall.

Wednesday, June 12, 10 a.m. to 12 noon.—The Institution of Mechanical Engineers.

Wednesday, June 12, 2.30 p.m. to 4.30 p.m.—The Foundry Exhibition.

Thursday, June 13, 10 a.m. to 12 noon.—The Institution of Mechanical Engineers.

Engineers' Club.—By kind permission of the Chairman and Committee, Members and Delegates may enjoy the privileges of Temporary Honorary Membership of The Engineers' Club, Coventry Street, W. Such Honorary Membership will only be extended to those in possession of the necessary card, which may be obtained by applying on the enclosed form.

Correspondence.—Members and Delegates may have their correspondence forwarded to them during the Congress addressed: "C/o H. G. SOMMERFIELD, Charterhouse Chambers, Charterhouse Square, London, E.C.1." Correspondence so addressed will be available at the Conference Office.

Life of Ingot Moulds.

In most steel plants, a questionable analysis is usually assigned as the main reason for scrapping ingot moulds. This explanation is, in most cases, based more on personal opinion than critical judgment. Other reasons are firecracking and rough or burnt surfaces; but these phenomena are mostly of a secondary nature. Careful studies of the various characteristics of walls of scrapped moulds reveal interesting facts which, if properly interpreted, would undoubtedly point out the directions along which, thermally and mechanically, a more efficient handling of moulds, and consequently further improvements in the life of moulds, would be possible. The results of a complete investigation is described in this article.

Characteristics of the Mould.

The mould selected for a study of the chemical and structural changes of ingot-mould iron during its service was one of the commonly used types, and the metal teemed into it was made exclusively in basic open-hearth furnaces, being in all cases of the lower-carbon type. A relatively high-silicon and high-manganese direct metal—seasoned for about 2 hrs. in the ladle—was used for the manufacture of the mould. The mould's dimensions were as follow:—Interior, top, 17 in. by 17 in.; interior, bottom, 19¼ in. by 19¼ in.; height of mould, 58 in.; thickness of wall, 5 in.

The average chemical analysis of the mould iron was determined from drillings taken across the whole section of the wall. It gave the following results:—Total carbon, 3.54 per cent.; manganese, 1.26 per cent.; phosphorus, 0.104 per cent.; silicon, 1.43 per cent.

Hardness tests, made by means of a portable Brinell-hardness tester on the face of the mould, averaged 108 Brinell numerals with a gradient of 9 numerals. A careful examination of the interior of the mould did not reveal any defects visible to the naked eye.

After finishing this preliminary investigation, 118 heats with an average carbon content of 0.21 per cent. were teemed into this mould before it was scrapped, due to "burnt interior surface." As observed on most ingot moulds of this type, the maximum of deterioration was at a point about 80 per cent. of the length of the mould measured from the bottom.

Examination of the Mould Wall.

To determine the chemical, physical and microscopical changes in the mould iron, the wall of the mould was cut transversely in the centre of each of the four sides, about three-quarters of the way from the bottom of the mould. From plates representing the thickness of the wall, drillings were first taken on 10 locations, and then these plates were tested at five locations for Brinell and Rockwell hardness ("B" scale) in 10 distances from the interior of the mould. The average results of these tests are graphically expressed in Fig. 1.

The chemical analyses revealed that practically all chemical constituents are oxidised near the interior portion of the wall, and, hence, that carbon, manganese and silicon relatively decrease whereas phosphorus and sulphur increase. The values observed directly on the oxidised interior of the mould correspond to the observations made during a similar investigation made on a large mould used in the manufacture of forging ingots.

It may be stated, however, that the changes, as observed in the large ingot mould, were not so drastic as in this case, due undoubtedly to the fact that the total time of contact between molten and solidifying metal and mould was shorter in the case of the mould described in the previous paragraph. One may only refer to the common practice in steelworks that ingots for rolling purposes—after teeming—are stripped in a much shorter time interval than forging ingots, which, in most cases, are left in the mould until black.

When studying the values obtained during the physical testing of the plates, it will be noted that, contrary to most assumptions, the centre of the mould wall is considerably softer than the outer layers, and, furthermore, that the layers corresponding to the interior of the mould become harder than the outside of the mould.

A careful consideration of all chemical and metallographical characteristics observed on specimens of the mould mentioned, as well as on other moulds, reveals the indisputable dependence of the size of graphite flakes not only on the chemistry of mould and ingot steel, but also on the relative temperature intervals during repeated heating and cooling. Thus, larger graphite flakes will develop in pearlitic cast iron with an increase of maximum temperature intervals, whereas smaller temperature intervals will decrease the size of the flakes. Larger flakes however, offer a decreased resistance toward intercellular cracks, thermal fatigue and oxidation of the mould metal, thus decreasing, in general, the number of heats per mould.

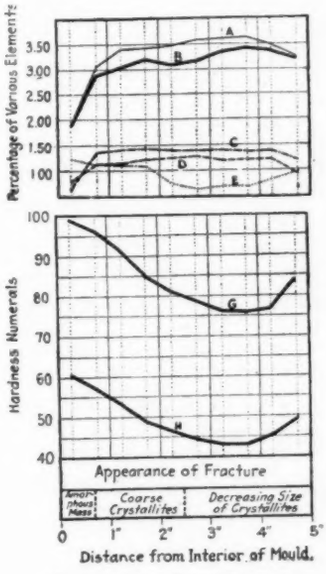

FIG. 1.—AVERAGE RESULTS OF TEST.

A = Total carbon. B = Graphite carbon. C = Silicon. D = Manganese. E = Sulphur (×10). G = Brinell hardness. H = Rockwell hardness (B scale).

This investigation, concludes MR. JOHN H. HRUSKA, writing in "The Iron Age," has revealed the chemical, physical and microscopical changes occurring in ingot-mould walls during the life of the mould. The rather theoretical conclusions of this work point out the importance of the size of graphite flakes as affected by the chemical composition of ingot moulds. As a result, the tendency of the mould foundry and ingot-producing department should be toward a decrease in the size of graphite flakes, which points primarily either to an addition of chromium to mould metal or to some other changes in chemical composition or the thermal treatment of ingot moulds.

Further, the investigation, together with other observations, points to the beneficial influence of an increase of the surface hardness of moulds which, in turn, depends upon chemical and thermal conditions in the manufacture, as well as thermo-chemical factors involved during the service, of ingot moulds.

Book Review.

PHOTOMICROGRAPHS OF IRON AND STEEL, by Everett L. Reed, S.B., published by Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, London, W.C.2. Price 20s.

The author of this book is an Instructor at Harvard University, and should not be confounded with Mr. E. L. Rhead, head of the Metallurgical Department of the Manchester College of Technology. The book is a collection of 218 micrographs of just ordinary materials encountered in ferrous metallurgy, and that is why it is so valuable, as it enables the metallurgist to compare his specimens and ascertain whether any of them is abnormal. We wish to thank the author (or should it be compiler) for differentiating so clearly between tempering and drawing. It seems that 400 deg. C. is the dividing line, tempering below and drawing above and up to the critical point.

There is a feature of this book to which we take exception, and that is that most of the micrographs have been reduced on reproduction and a new magnification stated. It is obvious that a certain resolution of constituents is established for each serious increase in magnification, and for comparative purposes this can be used—provided the work has been carried out correctly—as a standard. To show the inadequacy of this method, suppose one takes a microphotograph of a pearlitic cast iron at 1,000 dias., wherein the lamellæ of the cementite and ferrite will be resolved and then so reduce the picture that a magnification of a 100 diameters is indicated, the result would be to give the impression that the pearlite constituent is easily and splendidly resolvable into its constituents—ferrite and cementite—at the lower magnification. Few people have had more experience in the reproduction of micros than the reviewer, and he asserts that he has never yet met a case where exigencies of space or any other consideration has necessitated reduction in size. He admits that an insignificant reduction does often effect an improvement, but for the sake of scientific truth all should be treated alike, and reproduced unreduced.

The scheme of the book has been to start with pure iron, then dealing consecutively with commercial irons, steels both cast and fabricated and heat-treated; alloy steels, such as nickel, chromium, nickel-chromium, chrome-vanadium, manganese, high-speed and stainless and many other varieties, and finally with cast iron. This last section is distinctly disappointing, as we miss the micro-sections, which show to the exclusion of all else the graphitic structure, as we deem these to be particularly informative. Again, whilst there are three micros devoted to the phosphide eutectic, there is not one which shows it as a network. Again, we are astonished that such an erudite individual as a University demonstrator should show without comment two microphotographs purporting to represent the difference between semi-steel and grey cast iron, both having a pearlitic matrix, but the former having small and the latter large graphite plates. Whilst certain practical foundrymen and engineers may have a conception as to what is meant by semi-steel, the metallurgist, that is the user of this type of book, requires a certain amount of information before he can hope to effect a useful comparison. Semi-steel may be a 50 : 50 mixture, which in an apt simile Mr. David McLain likened to the war-time rabbit pies, which might consist of 50 per cent. rabbit and 50 per cent. horseflesh or one rabbit to one horse.

The author has thought it wise to include five appendices, all compiled from various sources or specially contributed by an authority. They deal with such subjects as the preparation of specimens, their etching, microscopes, photomicrography and metallurgical definitions.

D

Some Interesting Moulding Jobs.*

The Chairman (Mr. J. Longden) said that they had listened to a very interesting description of the practical moulding of three somewhat difficult castings. He thought that in the case of the last one it would be necessary to pour very quickly. He hoped that the practical moulders present would take the opportunity of asking questions or of expressing their opinion as to the methods described. There was often more than one correct way of making a casting, and it would be interesting to hear of other methods of moulding the articles which the lecturer had described.

Mr. J. Williamson said that in the illustration of the centrifugal pump shown he did not notice any branch or rings; was there no inlet on the casting? Was it not possible to make the cores off the mould by a clay thickness?

A Member said that he observed that most of the castings described were run from the top; was it not possible to let the metal flow round and come in from the bottom? He thought that if the metal was admitted from underneath and allowed to flow upwards cleaner castings would be obtained. As an engineer he had been greatly interested in the description of the methods necessary to produce castings, and was of the opinion that the majority of engineers had no idea of the trouble incurred in the production of their intricate castings.

Mr. Longden replied that if the last speaker would think back a little he would realise that the first casting described was cast from the bottom, the second partly from the bottom and partly from the top, and only the last was poured completely from the top. It was a matter of controversy in foundry circles as to whether top or bottom pouring gave the better results, and practical experience should decide upon the method to be adopted in each case. There was the danger that long castings run from the bottom the metal might partly or completely set before it had reached the end of the run. One was not always sure of getting perfectly clean metal by bottom running.

As regards the thickness, he thought that the first speaker had been rather confused, because he showed that he did make the thickness and then run off the cores. There was certainly an inlet shown in the pump drawing—a central hole for water, as well as an outlet on the pump.

Mr. H. Winterton said that for a long time the practical men had been crying out for papers of a practical nature. They had had one to-day, and now showed much reluctance to discuss it. He appealed to all the moulders present to come forward and take part in the discussion. As Mr. Longden had experienced some trouble with oil-sand cores, why not adopt some other kind of oil or other method so as to get rid of the troubles with gas and smell?

Mr. Longden replied that he had not indicated that he had experienced great trouble with oil-sand cores; he simply indicated the precautions taken to prevent the breakdown with the cores. Wherever possible he distributed the runners over the whole casting to reduce erosion of the core. He remembered the case of a gas-engine cylinder which was a waster because of the metal wearing away the core, which collapsed at that point. He definitely started out to make a success of oil-sand cores, but he knew the possibility of erosion and took all precautions to prevent it, but he did not have trouble, as Mr. Winterton appeared to think.

Mr. J. McEachern said he was interested in the author's remarks about cores; he understood him to say that he used a 25 to 1 mixture, and he thought it a good performance to get a strong core that could be tied up tightly with such a mixture. He thought 20 to 1 oil mixture was the usual practice.

Mr. Laurie, speaking with regard to the centrifugal pump casting, said his first attempt at such a casting was not done with strickles but with sweeps. It had not a cylindrical outlet but a square one. He was asked to make it the way the draughtsman had drawn it out and to do without patterns. He marked off a number of centres and made a spindle to fit the centres, and swept from the radius of the centre and then shifted the spindle to the next centre. He had six centres, and swept as far as the radius and then on to the next sixth. He thought that Mr. Longden had shown eight sweep boards, but each could only be used for the actual point for which it was made. It seemed to him that it would be an easier and cheaper way to make a plate on the pattern on each side. The job was one that had to be left very much to the imagination of the moulder; if he was unable to visualise the job from beginning to the end he would be in trouble all the time. There were very few really good loam moulders at the present time, and they were getting scarcer.

As regards the carding engine cylinder, he saw some being made at a foundry he visited during one of the conventions. He thought it was an excellent performance to mould and cast them the same day; it was, of course, the result of specialisation. The ordinary foundry would be required to make them with as little plant and as cheap as possible. If the moulder was given the order to make the casting and to give the best job possible then it would be a trade worth following, but the usual thing was the moulder received the pattern and was told to make the casting as cheaply and quickly as possible. The result was the engineering shop complained about defective castings, which was all because the moulder had never had a chance to make a good job.

He wished to ask Mr. Longden why in the first example he used a metal with 0.7 per cent. phosphorus for a casting which had to contract 2 in., as this left with the expansion to come on the iron. He would reduce the phosphorus for such a job. Then in regard to the sulphur, which was a hardening element, given as 0.2 per cent. He did not like sulphur at 0.1, and regarded 0.09 as the limit.

Mr. Longden agreed that the moulder was not given the opportunities of showing what he could do. In reference to Mr. Laurie's question about phosphorus content of metal in the centrifugal pump, there was no reason for putting expensive metal into it; by reducing the phosphorus to 0.3 per cent. the cost was increased. As regards sulphur, he believed that sulphur content was the important point. During the strike they found founders using metal with high sulphur, thought impossible by the metallurgists. He had never been able to get more than 0.2 per cent. of sulphur into the metal by repeated meltings; he was not afraid of sulphur, and had made liners out of all scrap charges. The withholding of tackle and plant to the foundryman was wrong, and he would refuse to be denied any tackle really necessary for a job.

Mr. T. Bell asked which core-oil was mentioned and also were the core-irons used in the centrifugal pump casting saved and used again or were they destroyed? He thought that in the West of Scotland they would hardly proceed in so elaborate a manner in making the cores, but would build the core with half-irons, because the core had to be slackened quickly, although it might be a little more trouble to the dresser.

Mr. Longden replied that there was no best core-oil to use; their number was legion, but they all knew that those with a linseed-oil base were the most suitable. With regard to Mr. Bell's remarks as to West of Scotland practice in making centrifugal pump bodies, he thought that he had lost sight of the fact that the core has to be relieved. He considered that such a core, built solid, would crack. The problem was to relieve whilst in the hot condition. There was no need to bother about the dresser. He considered that the method he had described was just as good and as quick as that mentioned by Mr. Bell. Relieving must be effected very, very quickly. Core-irons varied so much that he seldom saved them for use again.

The Chairman proposed a vote of thanks to the Author for his paper, and this was carried with acclamation.

Mr. Longden, in reply, said that it had been a great pleasure to visit the Scottish branch, and he thanked them for the opportunity of doing so. He thanked them for the hearty welcome given him and the manner in which they had received the Paper.

* Discussion on the paper read by E. Longden before a meeting of the Scottish and other branches of the Institute of British Foundrymen, Mr. J. Longden presiding, and published in our issues of April 18 and 25.

International Foundry Congress, June, 1929.

In connection with the above, Mr. H. G. Sommerfield, the Honorary Congress Secretary, announces the receipt of the following subscriptions: —

	£	s.	d.
Sir Wm. Larke	5	5	0
Hearn Foundries (Luton), Limited	2	2	0
The Rodney Foundry Company, Limited	2	2	0
F. A. T. Buckingham	0	5	0
Lake & Elliot, Limited (Braintree)	26	5	0
Entwisle & Kenyon, Limited ...	5	5	0
Lord Weir	25	0	0
John A. Smeeton, Limited ...	5	5	0
Thomas Turner	2	2	0
Ridsdale & Company (Middlesbrough)	1	1	0
F. P. Wilson	0	10	6
H. G. Summers	0	5	0
J. W. Jackman & Company, Limited	5	5	0
The Penton Publishing Company, Limited	5	5	0
Thos. Ward, Limited (Sheffield)	3	3	0
National Light Castings Association	50	0	0
G. E. Hider	0	10	6
H. H. Saunders	0	10	0
Morris Motors (1926), Limited...	10	10	0
John H. Clark & Company ...	15	15	0
Vickers-Armstrongs, Limited ...	15	15	0
Douglas Fraser & Sons, Limited...	5	5	0
Wm. Olsen, Limited, Hull... ...	1	0	0
Booth & Brookes, Limited ...	1	1	0
Kryn & Lahy, Limited	1	1	0
J. Stone & Company, Limited...	20	0	0
Davis Gas Stove Company, Limited	5	0	0
Thomas A. Spiers	5	0	0
Dewrance & Company	10	0	0
Benjamin Skidmore	0	5	0
Institute of Metals	15	15	0
J. & E. Hall, Limited	15	15	0
David Colville & Sons, Limited ...	5	5	0
F. Blackwell	1	1	0
Newton Chambers & Company, Limited	10	10	0
Standard Brass Foundry (Transvaal)	10	10	0
J. Shaw	1	1	0
Furmston & Lawlor (Letchworth)	1	1	0
The Louis Cassier Company, Limited	10	10	0
A. Hares	0	10	6

Institute of Metals.

The nineteenth annual May lecture will be delivered at the general meeting of the Institute, to be held at 8 p.m. on May 7, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1.

The lecture will be presented by Sir Oliver Lodge, D.Sc., LL.D., F.R.S., who has chosen as his subject, "Some Ideas About Metals."

Monel Metal.*

By W. McCulloch.

The President of the Scottish Branch of British Foundrymen, Mr. Longden, made mention in his Presidential Address that there was no difficulty in securing the services of highly competent men to lecture to the Institute on the theoretical or academic side, but it was very difficult to induce men who were actually engaged in practical moulding operations to state their views and experiences in the form of a paper. Speaking for the average moulder, it is with the object of trying to hide or keep everything to oneself, but rather a feeling of one's inability to put one's views on paper.

For many purposes castings are required having higher physical properties and greater resistance to corrosion than the usual brass-foundry alloys. For such applications, the best all-round commercial alloy to-day is probably Monel metal. This is a nickel-copper alloy, containing approximately 68 per cent. nickel; 29 per cent. copper, together with iron 2 per cent. and manganese 1 per cent.

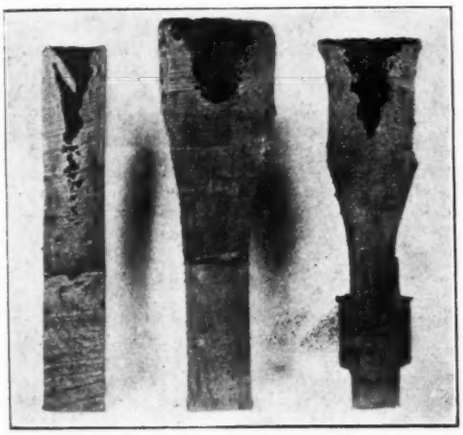

Fig. 1.—Showing the Necessity for Feeding Heads.

Particularly for castings which have to withstand the high temperature and severe conditions of superheated steam, Monel metal has become the standard metal. Valves, seats, rump-impellers, turbine parts, etc., in Monel metal can be handled satisfactorily in the ordinary brass foundry, with only such special equipment and special care and precautions required by its high melting-point and considerable shrinkage.

Melting Monel Metal.

For making sound castings, special attention must be given to the melting. The melting point is 1,360 deg. C., and the pouring temperature about 1,500 deg. C. The molten metal readily absorbs carbon and sulphur, the latter from the furnace atmosphere, which is injurious to the metal; therefore careful attention must be given to the handling of the metal in the furnace or crucible, as well as in the mould.

The quality of the casting depends greatly upon the quality of the metal put into the furnace, and difficulty may arise in the re-melting of headers, risers, etc., if these have absorbed carbon or sulphur in the previous melt. Monel metal can be melted successfully in graphite crucibles and in brick-lined electric-arc furnaces.

Melting time in the pit fire furnaces, with a 250 lb. charge, is two hours. It is necessary to have a good draught in the furnace to obtain the high temperature. The empty crucible is inserted into the pit fire and brought to a bright red heat. It is then lifted out and a new bottom of coke inserted into the fire; then the crucible is replaced in the fire and coke charged round the sides.

First 1½ lbs. of manganese ore is charged in the bottom of the crucible. This is put into the crucible to keep out carbon and form a good slag. This is followed by the small scrap, which is placed immediately on the top of the manganese ore; finally the ingots are placed crosswise on the top of the crucible. The whole charge of metal is inserted into the crucible at one time, and is placed in such a position that no coke, or practically none, gets into the crucible. The furnace is now filled to the throat and the fuel allowed to burn down. The crucible is then eased up and a new bottom put into the fire. This is essential, otherwise the crucible will be cold at the bottom and the desired temperature will never be attained. The fire is charged once more to the throat and allowed to burn down. The last charge should bring-down the metal ready for pouring. It is important that all the operations be carried out rapidly and no time lost. The time taken for melting never exceeds two hours. The weight of coke nuts used averages about 1 cwt. 1 qr. 18 lbs. per charge.

When the metal is melted and raised to the required temperature for casting, 2 lbs. of silicon is added. This acts as a deoxidiser, and is charged about five minutes before withdrawing the crucible from the furnace. Immediately after adding the silicon the metal should be stirred quickly with a rod or skimmer, to make sure that the silicon is thoroughly melted. Before pouring, further deoxidation is necessary, and this is carried out by the use of metallic magnesium.

Magnesium Deoxidation.

Generally 5 ozs. of magnesium is added to every 250 lbs. of metal. It is desirable to make part of this addition, say about 2 ozs., immediately before withdrawing from the furnace. The best method of applying the magnesium is on the end of an ordinary ⅜-in. malleable iron rod. The magnesium is supplied in 1-in. round bars, which are cut into lengths weighing one or two ozs. each; a hole is bored in the magnesium, and the point of the iron rod is inserted into it. This bar is then plunged to the bottom of the crucible. It is important to do this, otherwise it will burn on the top of the metal. When the metal has been withdrawn from the furnace, which should be done quickly, add the remainder of magnesium, an amount varying from 2 or 3 ozs. The crucible should then be skimmed clean of any slag, which, being of a sticky nature, adheres to the side of the crucible and the skimmer. After a little experience, one can easily tell by visually examining the metal, through blue glasses, when it is properly deoxidised. It can be seen to change colour, gradually assuming a greenish tint.

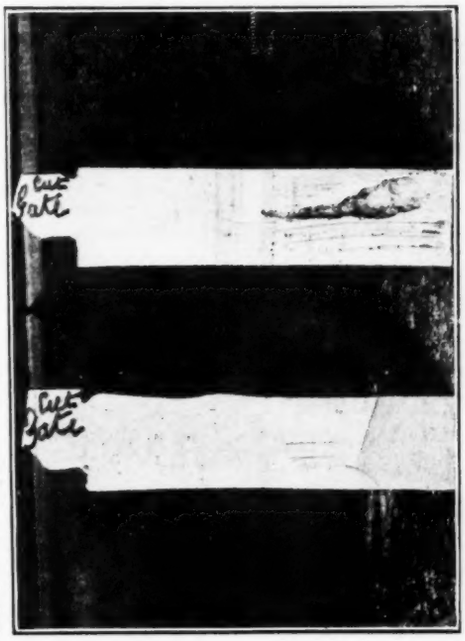

Fig. 2.—As Fig. 1 (left), but Cast Horizontally.

A suitable test of the success of deoxidation is to pour a small test-bar, say ⅜ in. by ½ in. by 6 in. If the metal has been completely deoxidised, this bar, when cold, will bend through 180 deg. on a radius of about 1½ in. without cracking. The deoxidation causes the metal apparently to lose its fluidity; therefore it must be poured quickly. All ladles or crucibles used for transferring metal should be pre-heated to conserve heat in the metal.

Melting should not be prolonged beyond the time required to reach the necessary temperature, but it is essential to have in the metal sufficient heat to cover transference losses associated with transporting the metal from furnace to moulds. Unless this is controlled the metal is liable to show cold sets or misruns.

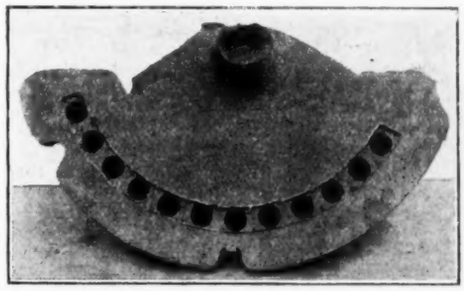

Fig. 3.—Nozzle Segment in Monel Metal.

When increased fluidity is necessary for making thin sections, a higher silicon-content is desirable. Silicon also adds strength and increases the hardness of the metal. The tendency to hot shortness, however, increases with high silicon, and is decreased by high manganese. Practice must be so controlled as to avoid formation of graphitic carbon in the metal, which makes it brittle.

Measurement of High Temperatures.

It would be very helpful if one could measure the temperature of Monel metal quickly and accurately. Unfortunately there is no apparatus which can do this economically. Optical and radiation pyrometers are available for high temperatures, but they only measure the heat or light radiated from the surface. The accuracy of the reading is very much affected by the presence of slag and also by the conditions of the test. Metal inside a furnace shows quite a different reading from metal in the open air; even though the temperature is the same in both cases.

Accuracy demands an immersion pyrometer for molten metal, and for ordinary foundry work speed is a necessity. This in turn necessitates the use of a bare wire couple. Such couples are available up to about 1,250 deg. C., but for temperatures in excess of 1,300 deg. C., no couples are yet commercially available.

Oil Furnace Melting.

The average time for melting 250 lbs. of Monel metal in the oil furnace is from 1 hr. 45 min. to 2 hrs., 2 hrs. never being exceeded. The oil consumed for the average heat is 15 gallons, whilst the air pressure at 60 lbs. is used. A test

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. J. Longden presiding.

piece was cast from every heat, and so far the author has found only a trace of graphite present in the metal in about two or three heats out of 60 casts. It is also noteworthy that the number of heats from the crucible used in the oil furnace is exactly the same as those used in the pit fires—namely, 14.

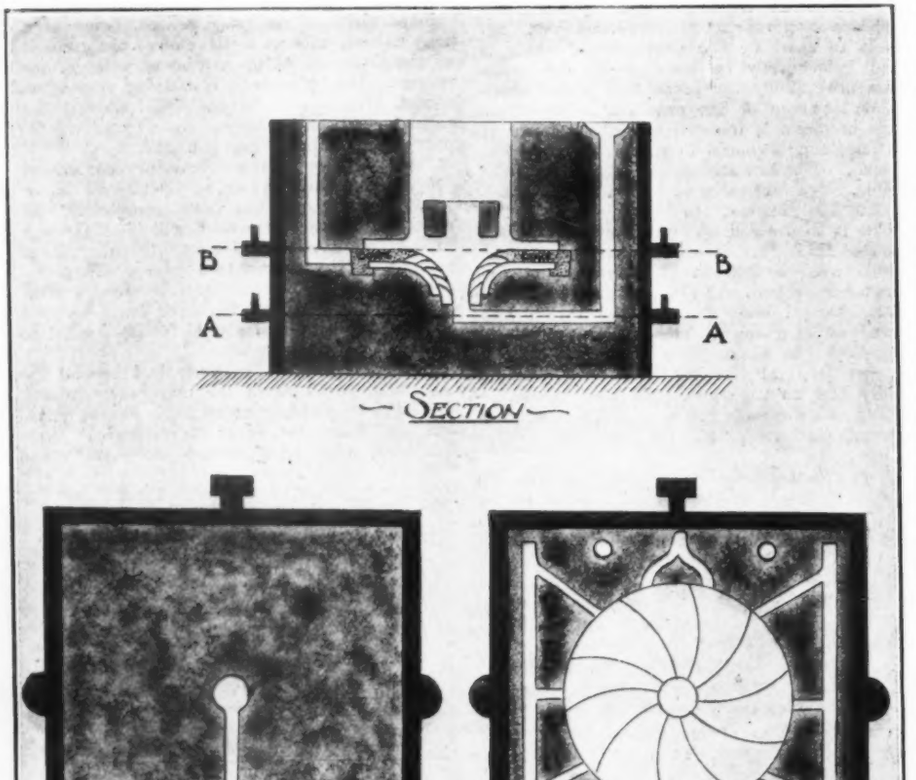

Fig. 4.—Moulding Details, using a Three-part Box for making Impellers in Monel Metal.

Moulding.

The practice followed in making sand castings of Monel metal is similar in some respects to steel foundry practice, and in others to iron or brass foundry technique. The methods of moulding, gates and risers necessary for feeding, very strongly resemble those of steel. The extreme care in moulding and ramming is similar to that used for the non-ferrous metals, the shrinkage being ¼ in. to the foot. Cores must be collapsible, to allow free shrinkage of the metal.

In moulding, no general rule can be given, as every pattern is a law unto itself. Headers and risers must be placed so as to feed the casting well and suppress shrinkage cavities. Sometimes it is best to feed the casting directly from the top; in other cases to feed it from the side, but no definite rule can be enunciated. The one characteristic to be kept in mind when moulding especially large and complicated castings is the shrinkage of the metal, and every precaution and care must be taken to allow the metal to shrink without being held in any way by the sand, such as avoiding freezing through a narrow neck in the riser. To fill the mould with metal, or to get a solid casting, this shrinkage must be taken care of by ample feeding through large sink heads and risers. Special care must be given also in moulding patterns which have abrupt changes in cross section. Ample fillets should always be used, and as far as possible sharp corners should be avoided.

Take an ordinary flange or cover with a boss on it, say 8 in. at the bottom, 4 in. at the top, 1 in. thick at the bottom flange and 4 in. deep at the top, cast with the boss uppermost with a fillet at its base. After the casting is stripped, one invariably finds practically no fillet at all; in fact, if it is cast with the first of the metal, when the temperature is high, or if the metal is not properly deoxidised, or again if the riser on the small size, one finds the casting drawn right under the angle at the base. Thin sections should be avoided on account of liability to misruns. Monel metal is sensitive to gas from core-binders, therefore this material should be kept to a minimum. An open sand should be used.

Dry-Sand Monel Metal Castings.

Castings weighing over 1 cwt. are generally made in dry sand—that is, whenever they have to be proof under pressure. If they have not to withstand any pressure, then latitude is given. Small castings are made in green sand, principally Belfast sand. In making green-sand castings, the moulder has his own rough and ready method of testing the sand. He rubs it between his finger and thumb in order to ascertain its texture or grain-size; then he squeezes a handful in order to test the bond or strength—not a very scientific way perhaps, but still very useful when associated with experience. Care must be taken not to work the sand too wet, and if the sand is of a close nature it is desirable to make it vent freely.

The author once made two castings in green-sand, each weighing about 50 lbs. One was made in Belfast sand; the other in rock sand. This was done to determine the difference between Belfast and rock sand when used as a mixture for facing. Both were cast green without any skin drying, just a little plumbago being brushed on the face of the mould. The casting produced in the mould made from the Belfast sand had a very good skin, but the one made in the rock sand was very rough.

The moulds are finished in the usual way, dressed with a little plumbago, but very little, and cast green, except when there is quite a large body of metal in the casting; then the mould should first be sprinkled with molasses water, plumbago brushed on the face of the mould, dusted with resin, and skin dried with a blow or gas lamp. All ornamental work is cast green without any skin drying.

When ramming the sand around risers, care should be taken to have it as soft as possible. When it is too hard the metal will not lie quietly, with the result, if there are two or more gates in the one box (which is very common if the best results are sought), the metal bubbling or blowing off the hard sand will roll into the next gate. Although it is only ⅛ in. in diameter, and it is followed up quickly by pouring metal into the same gate, the little ball, or pile of metal, will not melt and become part of the casting, but remains on the bottom of the mould, to fall out of the casting while dressing, or it may make a cold shut.

The casting temperature of Monel metal being high, the layer of sand forming the face of the mould is generally burned; therefore, the addition of new sand to the facing mixture balancing the discarded burnt sand is necessary. The object of the new sand which is added to old sand in order to form a mixture for facing consists in supplying to it whole grains which induce aeration and fresh bonding material, which, after being suitably prepared, restores cohesion.

Gates and Risers.

The feeding riser is a moulding tribute to shrinkage or contraction, and, from a moulder's

standpoint, is necessary for the production of good, solid castings in Monel metal. From the engineer's view, it is a necessary evil. Time and again founders have been told that the casting has neither shape nor form. According to the nature or shape of the castings when moulding, it is often necessary to cut off parts or pare the mould to suit to overcome the shrinkage,

Fig. 5.—Core for Impeller Castings.

resulting in the condemnation that it is the worst-looking casting that one could make. According to a contributor to the recent discussion on steel castings,* all holes are blow holes, or non-metallic inclusions, when in reality they are neither, but just "drawn" holes. Contraction is a decrease in the volume of a metal body, and is common to all metals and alloys, though not necessarily to the same degree. Between a light and a heavy section adjoining each other a severe rupture or cleavage may take place by the setting strain, the thin section cooling or freezing first; the heavy section, if it is not provided with a riser or feeder, when solidification takes place, will tear or crack away. Cases exist where, because of conflicting conditions, the metal has to be poured above or below the temperature at which its shrinkage is least expressive.

Castings, as, for instance, a disc 24 in. dia. by 2 in. thick, to be solid throughout, require a feeding riser. The distance from any one circumference pouring gate to the centre of the disc, and on to the extreme opposite point from this pouring gate, is too great to be completely dominated by the gate feed. This casting would need more feeding if cast horizontally. It would require three or four feeding risers, and if one is placed in the centre, it would require to be higher and heavier. The better method, then, would be to be cast vertically.

For a disc 12 in. dia. and 1 in. thick, with a solid hub 3 in. high in the centre, the casting could be run either from the circumference or from the hub, but in neither case could it be depended upon to control shrinkage in the hub; a feeding riser on the hub would be necessary.

The best pouring point is not always the best feeding point. It is sometimes necessary to put the riser on the side of the casting, which is used as a gate. Always have the basin or header about 1 in. from the casting, and on no occasion have it any farther away.

In side gates or risers a gate pin-hole often develops. A heavy riser or upright stack set over the gate, close to the casting, will supply and deliver a feeding quota of metal and obviate the pin-holes. It is bad practice in Monel metal to have too many castings connected with the one gate, for two reasons:—(1) It will be impossible to feed all the castings alike, the one nearest the pouring basin standing the best chance of being solid; the farthest away develops a pin-hole on the gate; and (2) in gate-cutting it is very awkward to get the saw blade in position, or the casting in position to suit the saw or gate-cutting knife.

Risers should be high, heavy and hot, and in direct and unbroken communication with the shrinkage loss. They should be placed as close as conditions will permit to the freezing zone, which is usually the centre of mass in the casting. Metal flowing from a mould into a riser is obviously colder in the riser than in the casting, and will naturally freeze quicker, which is the improper order for feeding, the correct condition being achieved by pouring hot metal back in through the riser into the casting whenever possible.

A riser (exhibited) illustrated the shrinkage of Monel metal. It was cut from an ordinary suction-valve seat, 14 in. dia., solid in the centre, having nine or ten 1½-in. dia. holes. In this head was seen the little beads which form when the metal passes from the liquid state into the solid, and which past experience has shown to be desirable, as it is usually associated with good metal beneath.

Fig. 1 shows a casting 2½ in. dia., 12 in. long, cast vertically with no feeding head. This was cut right through to reveal the draw, which is fully 70 per cent. of the full length; the same casting, when surmounted by a tapered head, was solid throughout, except for about 3 or 4 in. at the top. The third is a different kind of casting, with the same tapered head, and is also solid throughout, yet the draw on the head is about 25 per cent. of its full length.

Fig. 2 shows the same casting as Fig. 1 (left), but cast horizontally with a cut gate. The upper sample was cast with the first of the metal out of the crucible, and resulted in the top being irregular and the presence of a draw-hole. The other half had the draw-hole right up through the top. The lower specimen was cast with the last of the metal, and is sound throughout, except for some irregularity at the top. Monel metal is similar to aluminium inasmuch as that the higher the casting temperature, the greater the draw. This has been proved many times by casting two or more castings from the first and then the last of the metal in the crucible, the last generally proving the soundest casting. This is the reverse from gunmetal, wherein the lower the temperature, the greater the draw.

Nozzle Segments.

Fig. 3 shows a nozzle segment, which is a very important part of the turbine arrangement. It provides the means by which the steam passes from the steam-chest or valve-chamber to the blading. The blades or veins in the nozzle are set at a suitable angle, so that the most effective use may be made of the steam pressure. Initially this casting gave a great amount of trouble, owing to the light character of the blades associated with the heavy rim. If it was cast at a high temperature to ensure that the blades would run, then there was trouble from drawing on the flange. If, on the other hand, the temperature was kept low, then there were cold-shuts and misruns in the blades. All these segments were cast in green-sand, with the gate at the end. A core is made with a gate cut in it; this is first dried and then placed on the pattern near the bottom and rammed up in the box. This gives a good, clean gate with the metal running into the blades near the bottom of the mould. This method ensures against misruns or cold-shuts in the blade owing to having a supply of metal flowing up the blades until the mould is filled.*

Fig. 6.—Closing Impeller Moulds.

Impellers.

The author's firm manufactures a wide range of impellers. These are generally run from the bottom, although at times it was found necessary to run them from the rim. These castings (Fig. 4) are usually made in a three-part box, the metal being poured at the side. The gate is 1 in. dia., which leads into the channel at the bottom. There are either one, two or three

* "F.T.J.," January 24, 1929, page 72.

* The riser is in this case on the side of the casting with a heavy feed from the top. This casting is always cast on the "bank." When the mould is filled pouring is stopped; the gate is then covered with sand, and a weight put on the top; then hot metal is poured into the riser, which should be from 6 to 9 in. high, according to the size and weight of the casting. Since adopting this method the author rarely has a bad nozzle segment cast in Monel Metal.

inlets at the bottom of the casting, according to the size and shape. The centre riser is generally about 6 to 9 in. deep; the diameter varies according to the size of the impeller, with three or four feeding-risers, about 3 in. by 1 in., on the outer rim. This forms one main riser, which feeds the centre and the rims at the same time. The making of the moulds is comparatively easy compared with the confection of the cores.

The core (Fig. 5) is made up in sections of eight or ten, according to the number of blades in the impeller. These are then assembled together, care being taken that each blade is of the correct size and thickness. They are bound together with a piece of wire on the outside diameter and at the bottom print. The blades are required to be as thin as it is possible to cast them.

After they are assembled, each core is inspected before being placed in the mould. One way of doing so is by using a ball—an ordinary $\frac{1}{8}$-in. ball, such as is used for bicycle ball bearings. This is then passed through the spaces provided for the blades. Some of these blade cores are about 12 in. long, 2 to 3 in. broad, $\frac{1}{4}$ in. thick or deep. At first there was great difficulty in providing a sand against which the Monel metal would lie. On no account must the metal "simmer" against the core, but, on the contrary, must lie absolutely quiet; so a core has to be made so free and permeable to gases that the only path the gases could take was back in and through the core.

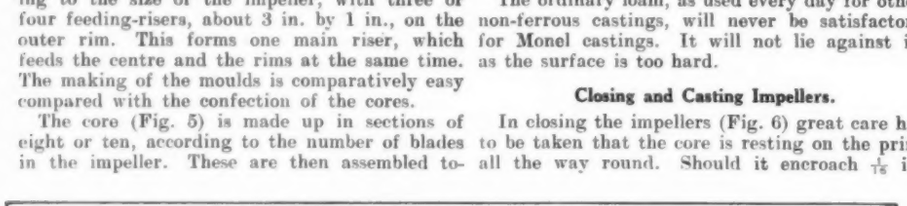

Fig. 7.—Two Types of Impeller Castings with Risers.

Fig. 8.—A Heavier Type of Impeller Casting.

Small cores are made from Scotch silica sand bonded with "Glyso" oil, but the majority of impeller cores are made from ground ashes, Belfast sand, with gluterine or "Glyso" oil as a binder. Some of these cores, according to the size of the impeller and the method of casting, have to be tied down; therefore provision has to be made in the core before assembling.

The ordinary loam, as used every day for other non-ferrous castings, will never be satisfactory for Monel castings. It will not lie against it, as the surface is too hard.

Closing and Casting Impellers.

In closing the impellers (Fig. 6) great care has to be taken that the core is resting on the print all the way round. Should it encroach $\frac{1}{8}$ in. at any one blade, then the blade, being just that $\frac{1}{8}$ in. thick, when the top part is placed on the core, would twist—only that $\frac{1}{8}$ in., but sufficient to make it a bad casting. Care must be taken to have all the vents free, and provision made either through the joint of the box or up through the top. Since adopting Monel metal for impellers the author has cast over three thousand. There is a record kept of every impeller, date cast, and a serial number on each.

Fig. 7 shows two impellers, with a riser on either side; the impeller on the right is comparatively easy to make as compared with the other casting, as the latter has a thin core. The two heads are shown to illustrate the draw, but, unfortunately, their depth is hardly shown.

Fig. 8 is a different type of impeller, larger and heavier. The blades are $\frac{1}{4}$ in. thick, the core space between each blade being greater. They are easier to make, being run from the bottom with three inlet gates—one on either side of the rim and one at the centre boss. Provision is made for tying the centre core down through the drag. The riser being the full size on the centre boss, the core is cut away at the top; the core-box is made to suit. Each casting requires 4 cwts. to cast, including risers.

(To be continued.)

The North-East Coast Exhibition, Newcastle-on-Tyne, which is to be opened by His Royal Highness the Prince of Wales on May 14, 1929, will include exhibits of many well-known foundries, including:—Armstrong, Whitworth & Company, Limited; Vickers-Armstrongs, Limited; Birtley Iron Company, Limited; Swinney Bros., Limited; North-Eastern Marine Engineering Company, Limited; the Wallsend Slipway and Engineering Company, Limited; R. & W. Hawthorn, Leslie & Company, Limited; Tyneside Foundry Company, Limited; E. N. Mackley & Company; Head, Wrightson & Company, Limited; Wm. Doxford & Sons, Limited; Cortin & Corking, Limited; Consett Iron Company, Limited; Robert Bowran & Company, Limited; Swan, Hunter & Wigham Richardson, Limited; Clarke, Chapman & Company, Limited; Ashmore, Benson & Pease & Company, Limited; and J. Holmes & Company, Limited.

The System Magnesium-Zinc*

By W. Hume-Rothery, M.A., and E. O. Rounsefell, B.Sc.

(1) The equilibrium diagram of the system magnesium-zinc has been investigated in the range 0 to 70 atomic per cent. magnesium, the magnesium-rich alloys having already been studied by Hanson. Particular attention has been paid to the structure of the solid alloys and the limits of solid solution in the various phases. Twenty-three points on the liquidus have also been determined, but this part of the diagram is already well known.

(2) The solid solubility of magnesium in zinc increases from about 0.15 atomic per cent. magnesium at 200 deg. C. to 0.3 atomic per cent. at 364 deg. C., which is the temperature of the Zn-$MgZn_2$ eutectic.

(3) The temperature of the $MgZn_2$-Zn eutectic has been accurately determined by cooling curves and quenching experiments as 364 deg. C. In ordinary cooling curves it is liable to considerable fluctuations, which are regarded as due to the suppression of the peritectic reaction by which the compound $MgZn_2$ should be formed at 381 deg. C., but which in practice is delayed, so that it occurs at the same time as the eutectic separation.

(4) The compound $MgZn_2$, previously discovered by Chadwick has been confirmed, but the solid solution in this compound which was claimed by Chadwick has been shown not to exist. This part of the work has been carried out in great detail, and it is shown that after prolonged annealing an alloy containing 16.5 atomic per cent. magnesium shows traces of free zinc, whilst one of composition 16.8 atomic per cent. magnesium shows traces of $MgZn_2$. This corresponds to a difference of less than 0.1 per cent. magnesium by weight, and it is concluded that this is evidence of a compound of fixed composition.

(5) The compound $MgZn_2$, discovered by Grube, has been confirmed, but the wide solid solution in this compound claimed by Chadwick has been shown not to exist. This discrepancy is due to the fact that the acid ferric chloride etching reagent used by Chadwick does not distinguish clearly between the compound $MgZn_2$ and a new compound MgZn, which is described for the first time.

(6) A new compound, MgZn, has been shown to exist, and this also is of fixed composition. It may be distinguished from $MgZn_2$ by means of Benedicks' reagent. The compound is formed at 354 deg. C. by a peritectic reaction between $MgZn_2$ and liquid. The arrests corresponding to the formation of this compound were observed by Chadwick, who regarded them as due to a transformation of the supposed solid solution in the compound $MgZn_2$, but the present work shows conclusively that they are due to the formation of MgZn.

(7) These data, together with those of Hansen, enable the complete diagram to be drawn.

(8) On the practical side the present work shows that in Elektron metal, and similar alloys, any zinc present in excess of that contained in solid solution in magnesium will exist in the form of the new compound MgZn, and not, as previously supposed, as $MgZn_2$.

(9) The relations between the magnesium-zinc and magnesium-cadmium diagram are discussed. Both contain analogous rather unstable compounds, $MgZn_2$ and $MgCd_2$, but whilst the Mg-Cd system contains wide solid solutions in the parent metals, the Mg-Zn system shows little solid solubility in the two metals, but forms two very unstable compounds, $MgZn_2$ and MgZn. Evidence is given indicating that these may exist in the solid state only, and not as definite molecules in the liquid. It is shown that concurrently with these facts the atomic volumes of magnesium and cadmium are nearly equal, but differ widely from that of zinc.

*Extract of a Paper read before the Spring Meeting of the Institute of Metals.

The Change of the Total Carbon of Cast Iron during Melting.

In the first part of a research* H. Pinsl considered the factors which might influence the total carbon content of cast iron during melting. These factors are:—(1) The chemical analysis of the mixture; (2) the temperature of the iron; (3) the period during which the molten iron is in contact with the coke; (4) the solubility and the solution velocity of the carbon in iron; and (5) the general working of the cupola (volume and pressure of blast, charge coke, size of iron charge, etc.).

The influence of the different components of the iron upon the eutectic carbon content can be calculated according to the formula given by Fletscher:

$$C = 4.3 - 0.286\ Si - 0.387\ P + 0.018\ (Mn - 1.8\ S)$$

and the calculated values are, as the author shows, in good agreement with the experimental results of Morschel. The formula, however, only gives the carbon content at the eutectic temperature, and as the temperature of the molten iron is by far higher, and as the iron is in intimate contact with the coke for some time, one might assume that the actual carbon content must be higher than the eutectic content calculated by Fletscher's formula. But this is not quite true, as the author shows with the aid of many cast irons taken from literature. Most of these irons have a carbon content which is below the calculated eutectic content, and only with three irons (out of 41) the carbon content is higher (up to 0.08 per cent.). Furthermore, irons which differ greatly in silicon and phosphorus do not differ but little in carbon content. When hypereutectic pig-iron is re-melted the carbon content of the melt is, for the most part, below the calculated eutectic content; only with pig-iron high in manganese is the original carbon content but slightly changed. Here, as the author states, the solidification occurs along the lines of the carbide system, and, as the manganese carbide has a high specific gravity, it will not float to the top and separate from the melt, as it the case with graphite. When cast iron is re-melted several times the total carbon content, in most cases reduced below the eutectic value by the first re-melting, remains nearly constant, though, according to Fletscher's formula, it ought to increase as the silicon content continually decreases. From these facts the author concludes that every cupola under definite working conditions produces a definite and constant carbon content. This opinion was checked by experiments, the results of which are illustrated in Fig. 1. It is

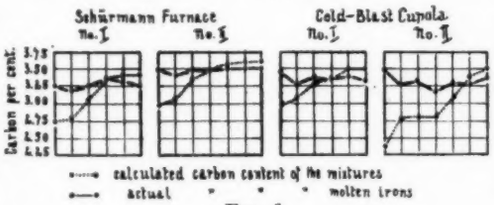

FIG. 1.

to be seen that for each furnace the carbon content of the melt remains nearly constant, though the carbon contents of the respective mixtures differ greatly from each other. The working conditions of the cupola remaining constant, the definite carbon content is only changed when the phosphorus content of the mixture is greatly altered, as can be seen from Table I. Here, between two mixtures rich in phosphorus, five tons of hematite were melted; the total carbon of the melt increased from about 3.35 to about 3.75 per cent. Summing up, the author states that the chemical constituents do not greatly affect the total-carbon content of cast iron; only a high manganese content may retain the hypereutectic carbon of the pig, and a very low phosphorus content seems to be associated with a higher carbon content.

* "Die Giesserei," 1928, No. 52, pp. 1292/1301.

As to the other factors influencing the total-carbon content, it can be seen from the foregoing considerations that the temperature does not play such an important part as may be concluded from the theoretical point of view; in spite of the higher temperature, most of the irons mentioned in literature show a total-carbon content actually below the eutectic value. It is rather the period during which the iron is in contact with the coke which plays the greatest part; this period is greater with cupolas without receivers, where the molten iron remains in contact with the bed coke. Here, to keep the carbon content low, the period of working the charge must be diminished. Besides the time-factor, the original carbon content is important. Under the same working conditions, steel scrap will absorb more carbon than cast-iron scrap, the carbon content of which is nearer to the saturation point. As to the solubility and the solution velocity of the carbon in iron, only few data are found in literature. The influence of the working conditions may be seen from the experiments referred to below.

TABLE I.

Heat. No.	Sample. No.	C	Si	Mn	S	P	Weight of heat Kg.
1	1	3.38	2.18	0.44	0.081	1.27	830
	2	3.44	2.24	0.43	0.092	1.34	
	3	3.43	2.25	0.43	0.079	1.33	
2	1	3.38	2.36	0.53	0.084	1.05	2,620
	2	3.43	2.43	0.53	0.073	1.05	
	3	3.58	2.57	0.58	0.055	0.68	
	4	3.65	2.79	0.66	0.033	0.25	
	5	3.67	2.87	0.64	0.037	0.16	
3	1	3.73	2.75	0.65	0.033	0.093	—
	2	3.73	2.73	0.68	0.037	0.095	
	3	3.77	2.68	0.64	0.035	0.093	
4	1	3.75	2.66	0.65	0.035	0.093	1,630
	2	3.76	2.71	0.65	0.031	0.100	
	3	3.77	2.60	0.66	0.038	0.138	
5	1	3.69	2.38	0.56	0.055	0.60	850
	2	3.66	2.37	0.58	0.066	0.70	
	3	3.66	2.23	0.54	0.07	0.86	

Diameter of cupola: 900 mm.
Charge coke: 9 per cent.
Weight of iron charge: 500 kg.

Influence of Diverse Factors.

Experiments were made to produce an iron with low carbon content. Six cupolas, of 900-mm. dia., were used, two with a receiver, two without a receiver, and two cupolas of the Schürmann type (hot blast). The experimental mixture was melted at the beginning of the day's run, and was followed by mixtures for normal production (pipe or engineering castings). The temperature was measured with an optical pyrometer. From every heat several samples were taken from the spout. The influence of the following factors was investigated:—(1) Type of furnace; (2) weight of iron and coke charge;

Experiment No.	2	4	8	11	15	16	18	19
Furnace No.	I	I	I	I	I	II	I	II
Weight of Iron Charge Kg	475	460	460	500	500	500	500	500
Number of Charges	8	10	14	8	6	6	6	6
Charge Coke per cent.	14	15	15	12	12	11	12	11
Mixture per cent.	55% Buffer Springs 45% Hematite	50% Rails 50% Amberg Pig	60% small-sized Scrap 40% Amberg Pig	as Exp. No. 8	60% Rails 40% Amberg Pig I	60% Rails 40% Hematite 40% Amberg Pig I	60% Sheets 40% Hematite 40% Amberg Pig I	60% Rails and Sheets 24% Hematite 11% Amberg I 4.5% Si-Packets 0.5% Mn- "
Analysis of Mixture	1.6 Si, 1.03 Mn 0.06 P, 0.013 S 1.99 C	1.68 Si, 0.56 Mn 0.07 P, 0.017 S 1.89 C	4.3 Si, 1.7 C	1.7 C	1.395 Si, 1.43 C	1.2 Si, 0.37 P 1.75 C	as Exp. No. 16	2.58 Si, 0.76 Mn 0.21 P, 0.035 S 1.41 C
Amount of Blast m³/min.	80.3	75.3	75.3	57.6	67.3	56.3	68.3	64.1
Pressure of Blast mm. Water Gauge	430	465	450	440	445	395	391	391

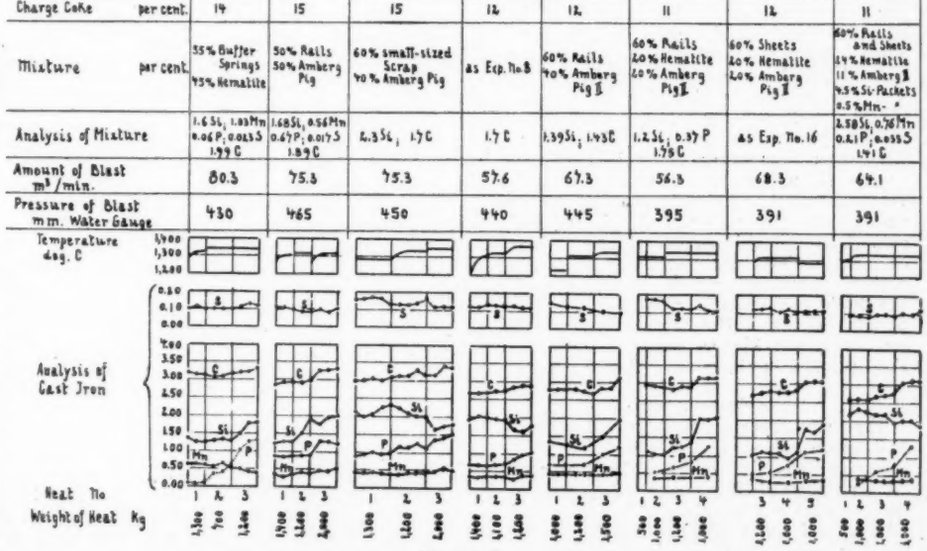

FIG. 2.

(3) volume and pressure of blast; and (4) coating the coke with a protective covering (Corsalli process).

Tests on Cupolas with Receiver.

The experimental conditions and the results are recorded in Fig. 2. In the first three experiments (Nos. 2, 4 and 8) the weight of the iron charge was low, and it is to be seen that a perceptible decrease in carbon did not take place. That the carbon content in experiment No. 4 is somewhat lower than in experiment No. 2 may be attributed to the Amberg pig-iron, which is high in phosphorus and therefore more easily melted than hematite; more heat-units are thus reserved for melting the rail scrap. In the following experiments the weight of the iron charge was increased and the coke charge decreased to 12 per cent., for it was known that under these conditions the furnaces worked most favourable. The result was that the average carbon content decreased to about 2.7 per cent. In experiment No. 11, where small-sized scrap was used, the carbon content is the lowest; one may conclude that, by using briquetted steel turnings, which are more easily melted, the carbon content will further decrease. In experiment No. 19 an iron was produced of the composition given by Emmel; of this iron a cylinder with a wall thickness of 10 mm. was cast, and the test-bars taken from the centre of the wall gave a tensile strength of 23 to 27 kg./mm.² (14.6 to 17.1 t/sq. in.).

Making Low T.C. Iron.

The experiments show that the measures to be taken for reducing the carbon content are:—The weight of the iron and coke charge is adapted to the diameter of the cupola, and the scrap used must be as small sized as possible. These working conditions, however, involve a somewhat higher sulphur content than normal. As to the temperature of the molten iron, it must be remembered that the experimental mixtures were melted at the beginning of the daily work, where the full height of the temperature was not yet reached; the temperature measurements are given without corrections.

Experiments with Cupolas without Receiver.

From the ten experiments recorded by the author, it is to be seen that here, too, a decrease of the total carbon content could only be attained when the furnaces were worked under conditions where they showed the best thermal efficiency, the weight of the iron charge being 500 kg. and the blower working at full speed (blast pressure, 500 to 600 mm. water gauge; blast volume, 70 to 75 mm.³ per min.). The influence of the mixture, however, is greater than in the former case. The lowest carbon content (average value, 2.81 per cent.) was found with Amberg pig-iron (40 per cent.) and small-sized scrap (60 per cent.); when rail scrap was added the carbon content increased to 3.0 per cent. Decreasing the pressure and the volume of the blast (370 mm. water gauge and 46 m.³ per min.) slackened down the melting process and increased the carbon to 3.5 per cent.; decreasing the weight of the iron charge did not prove a remedy. Increasing the volume of blast to 107 m.³ per min. gave a carbon content of 3.0 per cent. and a high loss in silicon. The Corsalli process (coating the charge coke with lime) did not prove successful, the carbon content being 3.05 per cent.; besides this the high gas content of the iron resulted in porous castings. The temperature of the iron was somewhat higher (average 1,370 deg. C.), the heat loss in the receiver being eliminated.

Schürmann Furnaces.

The three experiments show that a decrease of the carbon content can only be reached when an easily melted mixture is used; 50 per cent. of Amberg pig and 50 per cent. of small-sized scrap gave a carbon content of 2.8 per cent., whilst adding rail scrap (60 per cent.) and hematite (24 per cent.) increased the carbon to over 3.0 per cent.

The Quest for Markets.

By C. Percy Lister.*

When trade is bad it is the easiest thing in the world to blame the other fellow for it. If we in Britain cultivated a little more enthusiastically the habit of blaming ourselves and then of putting things right, trade would soon begin to improve.

What are the facts? The fact is that in a small country like ours, with a vast population, we have either to export our goods or starve. At the moment we are not exporting enough, and thousands of our people would be starving if we did not provide for them out of public funds. To provide these funds we are taxed up to the hilt, and our costs go up in consequence. Hence it is more difficult to sell our goods. Hence more unemployment, and the vicious circle is complete.

Somehow or other we have got to break it, and we can best break it by our own activity. We must break it or it will break us.

Take the European markets for a start.

We are often told that it is impossible for Great Britain to compete in the European markets. That, in my view, and I have proved it myself, is frank nonsense.

Every year I visit the bulk of the Continental markets from Lisbon to Lemberg and Calais to Constantinople, to meet personally our agents, distributors of our goods and executives of our subsidiary companies. These visits are supported by full-time representatives, with the result that our trade is increasing from year to year in each and every country covered, with the exception of those where business is made impossible by the prohibitive tariffs.

I claim no special merit for this increase; I mention it simply because I think it indicates what can be done by firms who are prepared to examine the prospects of new markets upon the spot. The people of Europe, after all, should be better acquainted with our people and the quality of our goods than the inhabitants of countries situated at greater distances from our shores.

Repeatedly I have heard it stated that British products are invariably of practical design, but it would seem that their distribution is often in the hands of either the wrong type of firm or one which is unable to do full justice to the goods. This, in my opinion, can only be overcome by the principals of manufacturing companies obtaining personal knowledge of the problems of the different markets so that they are in a position to give proper support to their full-time salesmen, and thus produce the best results.

Agricultural Machinery Imports Predominant.

The chief industry in most of these countries is agriculture. As a result of the war there is a dearth of modern implements. That, coupled with the more stable economic and social conditions now ruling, unquestionably makes them worth the closest attention by the British manufacturer. Our competitors in Central Europe and America have already realised that, and are cultivating them very carefully.

Of course, they are credit markets, but if connections are carefully selected on the spot, no greater risk is run in Central Europe than in other parts of the world in which credit is freely given.

Time was when an Atlantic crossing was a long and perilous undertaking, and when Europe was a field so vast that only the hardy and the leisured could tackle it. But times change, and we have got to change with the times. A transatlantic or European journey has now shrunk to the dimensions of a journey from London to York a century ago. But the old illusions persist, and some British business men still look on distances through the wrong end of a telescope. They have not adjusted their viewpoint.

* Managing Director of Messrs. R. A. Lister and Company, Limited, one of the largest foundries in the West of England.

Large potential markets such as Canada, Central America, and South America, to mention only three, are falling to a great extent into the hands of our competitors from want, I firmly believe, of personal touch and lack of knowledge of the problems of these export markets.

In my opinion one member of every Board of Directors of manufacturing concerns should be responsible for visiting these overseas markets for which the products of his firm are suitable. It is no use relying on Government Departments and Trade Associations, for, though these are very useful in their way, even they admit that to turn to the best advantage the information they provide it must have the backing of knowledge gained by personal visits. In the case of my own particular firm we have for some years followed the policy I am advocating here: our Directors are continually on the road both at home and abroad.

This year Directors or executive heads travelling with the status of Directors, with full power to act, are combing every continent of the world with a view to assisting or improving upon the Lister organisation. For, though our trade during the past six years as the result of this policy has greatly increased, we believe and are encouraged by the fact that there still remain enormous opportunities for further increases for those who are prepared to go out as our ancestors did and secure business in markets where there exists a demand for goods that can be met by enterprising British manufacturers. The executives of firms who have the courage to go and do likewise will return having not only accomplished something on behalf of their own particular industry and those dependent on it, but having tangibly assisted in the alleviation of one of our greatest national problems.

In conclusion, I am reminded of the words of one of the greatest of the pioneers of the British export trade, the late Lord Leverhulme, who said:—

"We own, notwithstanding our extraordinary methods of doing things, the finest trade mark in the world—*British Made*, a trade mark America or Germany, or any other country, would give untold millions to possess, a trade mark which stands for quality, for design and good workmanship. We have that, and all we want is increased production."

Iron and Steel Output in March.

The National Federation of Iron and Steel Manufacturers report that the number of furnaces in blast at the end of March was 145, a net increase of five since the beginning of the month, seven furnaces having been blown in and two having ceased operations. The production of pig-iron in March amounted to 590,500 tons, compared with 519,600 in February and 592,600 tons in March, 1928. The daily rate in March was thus 19,048 tons, compared with 18,537 tons in February. The production included 189,300 tons of hematite, 251,200 tons of basic, 108,300 tons of foundry and 21,300 tons of forge pig-iron. Production of steel ingots and castings in March amounted to 859,900 tons, compared with 774,900 in February and 793,300 tons in March, 1928.

An agreement regulating the wages of furnacemen in the Sheffield district has been arrived at between the Iron and Steel Trades Confederation and the Iron and Steel Trades Employers' Association. The agreement affects men in the employment of Messrs. Samuel Fox & Company, Limited, Stocksbridge; Cammell, Laird & Company, Limited; Penistone works; J. Lysaght, Limited, Scunthorpe; the Frodingham Iron and Steel Company, Limited; the Appleby Iron Company, Limited; the United Steel Companies, Limited; and the Park Gate Iron and Steel Company, Limited. It will apply to men engaged on stationary furnaces, basic cold metal machine-charged; stationary furnaces, acid cold metal machine-charged; basic stationary furnaces, hot metal process; Talbot and tilting furnaces, hot metal. A datum line has been established for what is regarded as a normal output.

Physical Properties of Foundry Coke.*

PROFESSOR BRISCOE'S PAPER DISCUSSED.

In opening the discussion, MR. C. GRESTY said that he had been rather surprised to note, when the list of bodies represented on the Committee had been read out, that the Institute of British Foundrymen was not amongst them. He thought they ought to find out why they were not represented, as foundrymen formed an extremely important section of coke users.

Crushing Strength at High Temperatures.

He doubted whether foundrymen would agree with Professor Briscoe in what he said about the strength of coke being unimportant. He had met cases where the only explanation of something unusual happening in the cupola appeared to be that the coke was weak and easily crushed. The crushing strength of coke had been mentioned in the lecture, but he would like to ask whether Professor Briscoe had determined the crushing strength at high temperatures, say 1,400 deg. C. or even higher.

In giving the figures relating to the burden on the coke in a cupola or blast furnace, had the lecturer taken into account the additional load due to charging the furnace from a height many feet above the bed, and also that which occurs occasionally on account of the charges "hanging" and subsequently dropping perhaps a couple of feet? In connection with the tests of coke No. 33, he would like to know whether the gas analysis had been verified, as the figures were abnormal and did not appear to be adequately explained.

PROFESSOR BRISCOE said that he recognised that it was a serious omission that the Institute of British Foundrymen was not represented, and, as the Committee was meeting shortly, he would like to put forward that view. He agreed with Mr. Gresty that, through movement in the furnace, the pressure on the coke became very much greater, but he still thought that the margin between the strength of the coke and the load was able to take care of the difference. The poor behaviour of weak coke was due to its chemical rather than to its physical properties. It was thought that the low figures in the case of the gas analysis of No. 33 coke were caused by the fact that the coke was large, so that they did not get proper combustion of it. Down to the permissible limit, smaller coke did better work.

The Blast-Pressure Factor.

MR. MOLYNEUX remarked that there was a great difference between the maximum temperature in the laboratory apparatus and the cupola temperature, which must have been about 300 deg. C. higher. Was it possible to compare results when there was that big difference in temperatures? Would better results be obtained if one could use a positive blower in cupola practice, thus being sure of putting the same quantity of air through the coke, instead of using a fan?

PROFESSOR BRISCOE said that it had to be realised, of course, that they were limited in the laboratory itself to a temperature which could be measured by a thermo-couple. The parallelism which they had observed so far between the laboratory tests and the tests on a large scale afforded them good ground for hoping that they would find that the laboratory tests were a useful indication of the large-scale tests. A positive blower would be an advantage if it were feasible, but the advantage of using a fan was that they were working under conditions common in cupola practice.

MR. W. J. PAULIN said that Professor Briscoe had made a rather cryptic remark which, if he had noted it down correctly, was "the amount of iron melted depends on how much coke you can burn." He thought that this remark might be rather misleading, because, if the quantity of coke charged in a cupola were increased above the normal, the coke bed would be gradually raised, and melting would be actually lower. Professor Briscoe had laid stress on the desirability of not paying too much attention to the hardness of coke, and therefore its possibility of destruction due to shattering in the cupola. He remembered going through Mr. Patterson's works and noticing the way in which heavy charges were shot into the cupola, and it struck him that under such circumstances the coke had to withstand a great deal of impact. Professor Briscoe had mentioned that the cupola used had a diameter of 5 ft., and that there was no variation in the blast pressure. It might be of some interest if they knew what the blast pressure was and whether he had felt that it would have been desirable to vary that in relation to the hardness of the coke in the various samples treated.

In reply, PROFESSOR BRISCOE said that, in making the remark quoted by Mr. Paulin, he ought to have added the proviso, "assuming that the ratio of coke to iron was about right." He quite agreed that, working with a high proportion of coke, one might not get the proper parallelism between the blast and the iron melted. With reference to the question of strength, he explained that, although pieces of iron fell on the coke with considerable impact, it was surprising how little smashing of coke took place. He supposed that the impact was taken to a considerable extent by the iron which was already in the cupola. With regard to the blast pressure, he thought he had indicated that he would have liked to get a higher pressure, because he considered that better results would have been obtained, but the circumstances were such as to render an alteration in the pressure undesirable.

MR. PATTERSON (past-President of the Institute) said that he could confirm Professor Briscoe's theory as to small coke, inasmuch as they had used coke on their small furnace with gratifying results, which led one to think that, provided the blast could penetrate the bed of coke, really good results could be obtained. Their blast pressure on the large furnaces was, he thought, 16 to 18 ozs., and on the small furnace about 8 ozs. The pressure penetrated a long way, whilst on the small furnace even a lower pressure penetrated to the centre. They obtained the same output per square inch of area on the small furnaces as they did on the big ones. If they used big coke on the small cupolas, they got comparatively poor results. It seemed, therefore, that if one did not get close contact between blast and coke, the results were poor.

PROFESSOR BRISCOE said that it seemed to him reasonable to think that the difference in the height of the charge in the baby cupola as compared with the big one had an important effect on getting the blast through. On the little cupola there was a height of charge about one-third of that on the big one, and evidently there was a real difference of pressure on the baby one; it would be about two-thirds as much in the baby cupola as the larger one.

MR. PAULIN asked if it would not be reasonable to suppose that on the smaller diameter cupola the centre was reached before the entering air had an opportunity of rising to too great a height, whereas with the 5-ft. cupola the opportunity for the air to rise was considerable, and it rose in a curve towards the centre and so automatically raised the melting zone.

MR. PATTERSON said that he did not think the melting zone in the big cupola was at all high. He thought he was right in saying that there was a well-defined melting zone starting not more than 8 to 10 in. above the top of the tuyeres.

PROFESSOR BRISCOE agreed with Mr. Patterson's observations; the melting zone, in his opinion, was 18 in. to 2 ft. deep, beginning 9 in. above the tuyeres. The experiments they had made on blast furnaces showed that even with a blast furnace of large diameter, 15 ft. to 20 ft., the blast went into the charge in a horizontal direction.

Analogy between Cupola and Blast Furnace.

MR. RIDSDALE (Middlesbrough) said that he would like Professor Briscoe to give them some idea of the thickness of the layer of coke they were using in the experiments; he would also like to know whether Professor Briscoe thought that the thickness of the layer should be reduced when the coke was reduced in size. Could he tell them what the essential differences were between blast-furnace coke and foundry coke?

Volumetric Coke Ratios.

PROFESSOR BRISCOE replied that Mr. Ridsdale's question was rather a difficult one to answer, and he was not yet in a position to answer it. The requirements for the blast furnace and the foundry were really the same, but one sometimes had to put up with an inferior coke in the blast furnace, a coke which one would not tolerate in the cupola, because the quality of the coke was more important. With regard to Mr. Ridsdale's other question, he thought the matter was automatically regulated, as the region of high temperature in a large coke was more spread out than in the case of a small coke.

MR. RIDSDALE said that he must not have made himself clear. What he had meant was the actual charge of coke as charged in at the top, and what he wanted to know was whether, in a big series of tests, if he knew what the thickness of the ring of coke was and if, when using a smaller coke, he would recommend a thinner ring of charging coke.

PROFESSOR BRISCOE said that he still thought that it would be automatically regulated; if the coke were smaller, it would occupy a different space. At the same time, he did not believe that the coke stayed in a separate layer. He thought that the coke would filter into the interstices of the iron.

MR. WATSON said that Professor Briscoe had mentioned that when he tested one coke he had built a brick ring the same diameter as the internal diameter of the furnace. Would he reduce this?

MR. RIDSDALE said that this was really what he was trying to find out. Was the thickness of the ring altered in proportion with the weight of the metal charged?

Temperature-Reading Difficulties.

MR. STOBIE, referring to the cupola tests, said that he wondered why the results of the experiments were not comparable in each case. Perhaps there was something due to the method of reading the temperature of the metal. In reading metal temperature with an optical pyrometer there were fumes which made the reading the same, although there were differences in the temperature of the metal. He would also like to know whether Professor Briscoe had made any comparisons on the cokes so that one might see the relation between the shatter and trommel tests. It might have a considerable bearing on the question which had been put by the President.

PROFESSOR BRISCOE quite agreed with Mr. Stobie that it was necessary to make certain that their temperatures were true ones. Through the co-operation of Mr. Robinson, of the Cambridge Instrument Company, they had been able to make quite sure. They had made one or two attempts to get the temperature in the cupola, but it really was not a very practical proposition. They had had to rely, therefore, on the

* See last week's issue.

temperature of the metal stream. They had not much evidence of comparison between different tests on cokes. This was one reason why he thought breakage by impact was probably not so important as the chemical nature of the coke. On the other hand, they had quite definite evidence from the laboratory that the chemical properties of the coke were about the same.

Dr. W. Braunholtz said that, in connection with the comparison of laboratory and cupola tests, they were working in the laboratory tests with definitely-graded-size coke, whereas in the cupola tests the grade of the coke was not exactly the same. It was, therefore, quite possible to explain the differences in the carbon monoxide and carbon dioxide ratios to some extent by the differences in the grading of the coke used.

A vote of thanks, proposed by Mr. Gresty and supported by Mr. Smith, Vice-President of the Middlesbrough Branch, was carried with acclamation.

The Balance-Sheet.

Checking Power Consumption of Foundry Plant.

By "Economist."

It is not suggested that the accountants' meticulous care in tracing a missing penny in the balance-sheet should be applied to the supervision of power-plant operation in a foundry, but with the present range of recording instruments available there is every reason why the aim of the power user should be to measure the total output of energy into the plant and to account completely for its ultimate destination. The first attempts to prepare such a balance-sheet may reveal the fact that essential data cannot be determined from the reading of existing instruments. In such a case, additional instruments should be installed, otherwise it is impossible to exercise any control over factors which are sufficiently important to affect the balance-sheet. As the preparation of the latter proceeds, attention is compelled to the unproductive destination of a certain proportion of the energy input. From the completed balance it is impossible to see instantly how much of the energy expended is used to advantage, and where improvements are to be sought. Among the most important of these are attempts to find missing units. The unaccounted-for energy, determined by taking the difference between the known input and the measured output, is obviously unmeasured and almost certainly wasted. For both these reasons it demands, and will repay, investigation.

Accounting for Every Unit.

Though there is a natural line of demarcation between the power house and the consuming plant, the principle of accounting for every unit of electricity may be extended not merely into the various departments, but actually to individual machines. This task is not so formidable as it sounds; in fact, it is a simple matter where electrical energy is consumed. Inexpensive types of meters are available for recording continuously the individual consumption of the more important machines. Portable meters can be used to check the consumption of smaller machines at regular intervals; electrically controlled the recorders will measure the energy consumption of conveyors and other machines absorbing practically constant power, the actual value of the latter being checked periodically by a portable meter.

A Working Example.

Although not carried out to the full extent suggested above, a very good example of a scheme of keeping a check on power consumption was observed by the writer when visiting a well-known foundry on the South Coast. The main feeders bringing in the power supply from the local electricity undertaking passed through recording meters in the ordinary manner, these meters registering the total amount of current supplied to the consumer. From here the supply was taken to the main distribution panel, which was equipped with a range of meters attached to each departmental circuit as it left the board. Daily readings were taken and recorded on a chart, so that the management were able to see at a glance the curve of power consumed in each department. Should the chart at any time reveal a peak in the power consumption curve in any particular department, steps were taken next morning to ascertain the cause and its justification investigated. In this way a complete check was kept on power consumption, and any fault in the installation quickly detected. Here is a case where both the management and the engineer were determined to utilise electric power on economic lines. Too frequently a plant is electrified and left at that, until the annual balance-sheets reveal for the first time a figure for expenditure on power that might have been reduced if a careful check had been kept on consumption.

False Economy.

Another direction in which economy can be effected lies in the purchase of high full-load efficiency motors. To save a few pounds on a motor by buying one only 2 per cent. less efficient is "penny wise and pound foolish," because at the present cost of electric power, the more efficient motor will have actually paid for itself, in its saving of power, in a few years. As an example, take the price of a 10-b.h.p. motor, with an efficiency of 90 per cent. at ¾ load, at £30, and that of a similar motor with an 85 per cent. efficiency at the same load, at £25. Then, with electricity at 1½d. per unit, the relative running costs per annum for a 48-hour week will work out at approximately £125 for the higher efficiency motor, against £132 for the lower efficiency motor.

This means a saving of £7 per annum, which would pay for the higher efficiency motor in a little under five years, while the saving on the first year would more than pay for the difference in first cost.

Ironfounding Workers' Union.

In his annual report, Mr. H. Murdoch, the general secretary of the Central Ironmoulders' Association, refers to the fact that he has been permanent general secretary for 25 years, having been appointed on January 1, 1904. When he entered on his duties as general secretary there were eight districts in the Association—four in Falkirk, one in Edinburgh, Glasgow, Bonnybridge, and Bo'ness, with a total membership of 3,781, and with funds amounting to £23,469 8s. 5½d. To-day there were twenty-six districts, with a membership of nearly 9,000, and funds amounting to nearly £37,000.

It is now admitted what a vital part all workers play in the prosperity and welfare of the nation. There is nothing manufactured that the worker does not want and will not buy if he is paid a wage sufficient to enable him to do so. The old notion that prosperity is produced only by the buying of the wealthy class has been exploded. The man who still thinks in this mistaken vein is wrong in the very fundamentals of economics. Prosperity is not a product of the classes, but is the product of the masses. The new thing which has been learnt is that before one can have economic progress two things must be accomplished. The first is, to create a multiplicity of ideas, and the other is to enlarge the class of people that shares the multiplicity of desires.

He did not profess to know what the future of labour was going to be, but he did know that splendid results had been achieved during the existence of the Association, and if the future held in store for them the same advancement as had been accomplished since its inception, then labour was destined to share in the future more and more in the march of progress.

The membership of the Association at the end of the year reached 8,581, as against 8,518 at the end of 1927. It was encouraging to notice the upward tendency, but the increase in the view of the executive was very meagre when they considered the number of non-unionists that existed in the light castings industry. It was surely not asking too much of the delegates and shop committees to see that no non-unionist should be allowed to remain outside without some attempt being made to enrol them in membership. Reviewing all the circumstances prevailing during the year, they had every reason to be thankful for satisfactorily holding their financial position.

Production of Iron and Steel.

At the annual dinner of the National Federation of Iron and Steel Manufacturers, held on April 18 at the Connaught Rooms, Mr. E. J. Fox, the President, said that the cost of transport amounted to 25 per cent. of the total cost. While the production of steel in this country was comparable with our pre-war production, the amount of pig-iron made was 35 per cent. less than in 1913 and represented a reduction in annual output of over 3,500,000 tons.

Furnaces in Lincolnshire, Northamptonshire and Derbyshire were vying with one another in producing pig-iron at a cost which could be attained by no country in the world outside India. The pig-iron trouble was under-consumption. It was imperative that an increased consumption be established. In spite of the difference in wage levels, and the high railway rates (rates which were 60 per cent. above the pre-war level, while selling prices were only some 12 per cent. above that level), they had been making cheap pig-iron, which was testimony to the efficiency of their methods and the natural advantages which they enjoyed.

Pig-iron was the ultimate basis of the whole of our productive industry. British steel had so firmly established itself the world over for its quality, and the markets of the world were gradually learning from bitter experience of the expense of cheap quality, that it was to be regretted that cheaper qualities of material should find their way into this country to have the "hall-mark" of a British product affixed to them. For reasons difficult to understand—and certainly unfair—the rigid requirements applied to home products were often largely relaxed when applied to the foreign product.

Imperial Chemical Industries, Limited.

The directors, in their annual report to the shareholders in their section dealing with metal goods, state that the manufacture of metal products, the non-ferrous class, as well as military and sporting ammunition, continues to be successfully operated by the subsidiary companies at Birmingham, and the volume of business shows a gratifying expansion. It will be remembered that during 1927 the businesses of Elliot's Metal Company, Limited, and British Copper Manufacturers, Limited, were acquired. During 1928 negotiations were concluded for the purchase in 1929 of Allen Everitt & Sons, Limited, the premier makers of non-ferrous tubes in this country, and probably the world.

Unification of control of these various metal companies is practically complete, and is already showing savings of no mean order in overhead charges. Manufacture has to some extent been concentrated; larger schemes involving further concentration and modernisation of plant are under consideration, and it is confidently anticipated that when this work has been completed the metal companies will, in spite of severe competition, still further increase their sales, both at home and abroad.

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Trade Talk.

An order for a Ruths steam storage plant has been placed by Messrs. Francis Stevenson & Sons, Limited, for their Lawside dye works, Dundee.

Alloy Welding Processes, Limited, have removed their offices and works from 14-16, Church Street, Islington, to Ferry Lane Works, Forest Road, London, E.17.

Messrs. Bow, M'Lachlan & Company, Limited, Paisley, have received an order from the Chilian Naval Commission, London, for two single-screw tugs and water carriers.

Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, have removed from Kinnaird House, Pall Mall East, to Park House, 22-26, Great Smith Street, London, S.W.1.

Considerable damage was done by a fire which occurred at the James Bridge Steelworks, Wednesbury, of Messrs. F. H. Lloyd & Company, Limited. The fire started in the pattern-shop.

Ailsa Shipbuilding Company, Limited, Troon, have launched from the Ayr yard a twin-screw steamer, "Cobargo," for the Illawarra and South Coast Steam Navigation Company, Limited, New South Wales.

A considerable quantity of valuable machinery was destroyed by an outbreak of fire recently in the premises of the Pennycook Patent Glazing and Engineering Company, Limited, Bridgeton, Glasgow. The damage is estimated at £5,000.

Mr. J. S. Nuttall, chairman of Messrs. Platt Bros. & Company, Limited, of Oldham, who was a member of the British Trade Delegation to Russia, obtained from the Soviet Government an order for textile machinery of the value of over £300,000.

Messrs. Dorman, Long & Company, Limited, Middlesbrough, have booked an order from the South African Railways for 36,000 tons of steel rails. It is understood that part of the order will be distributed among other North-East Coast rail makers.

Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock, launched from their Cartsburn Dockyard last week the torpedo-boat destroyer "Anthony," which is the first vessel of the 1927 destroyer class ordered by the Admiralty to be put into the water.

Imports of iron ore into South Wales in March totalled 91,315 tons, against 109,963 tons in February. Supplies from Spain were reduced from 83,000 tons to 60,646 tons, but from Algeria increased from 8,660 tons to 12,725 tons. Imports from France fell from 7,493 tons to 4,244 tons.

Lithgows, Limited, Port Glasgow, have launched a single-screw cargo steamer which they have built to the order of London owners. The vessel is named "Subadar," and is intended for general carrying trade. Triple-expansion engines will be supplied by Messrs. David Rowan & Company, Limited.

The proposed increase in the capital of Steel Ceilings, Limited, to £115,000 by the creation of 450,000 shares of 2s. each has been approved by the shareholders. Consent has also been given to the proposals of the directors of the company for the acquisition of certain rights in other companies.

Messrs. Barclay, Curle & Company, Limited, have launched from their West Shipyard the fifth of the vessels they are building for the Canadian Lakes and Canals Steamships, Limited, for next season's trade. The machinery is being supplied from the builders' North British Engine Works, Whiteinch.

On April 18 the Mayor of Stafford and members of the Stafford Borough Council visited the Tixall Road works of W. H. Dorman & Company, Limited. They inspected the various shops, including the iron and aluminium foundries, the tinshop, pattern-shop, fettling-shops and the metallurgical laboratory, and witnessed the casting of an aluminium crank-case.

Intimation has been made by Messrs. Kerr, MacLeod & Facfarlan, chartered accountants, Glasgow, to the joint secretaries of the Board of Conciliation for the Regulation of Wages in the Pig-Iron Trade in Scotland that the average net selling price disclosed by an audit of the employers' books for the first quarter of this year is £3 11s. 11d. This means that there will be no alteration in the wages of the workmen.

Sir Arthur Rose, the chairman, stated at a special meeting, in Edinburgh, of the Arizona Copper Company, Limited, following the adoption of a resolution to sell the shares of the company in the Phelps Dodge Corporation to an American syndicate, that there would be distributed shortly 40s. for each 5s. share, and probably there would be 2s. 6d. or 3s. more later on. The company is to be wound up voluntarily.

Messrs. David & William Henderson & Company, Limited, Partick, Glasgow, put into the water on April 24 the first of the six cargo steamers ordered in November, 1928, by Messrs. Hogart & Sons, Glasgow. The "Baron Vernon" will replace the vessel of the same name which was sunk by a collision with the "Metagama" off Dumbarton in 1923. The new vessel is 3,700 tons gross and is 350 ft. between perpendiculars. She will be fitted with triple-expansion engines by the builders.

The shareholders of Messrs. Darwins, Limited, steel manufacturers, of Sheffield, have confirmed the proposed agreement for the sale of the undertaking to a new company to be formed. Mr. J. T. Rankin, who was appointed liquidator of the company in September, 1927, at meetings of the shareholders on Friday, April 19, stated that he regarded the future prospects of the company as very bright. Throughout the period since the liquidation both sales and profits earned had shown continuous increase, while the position regarding orders in hand was also very satisfactory.

The Aberdeen Corporation Gas Department have placed an order with the Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Limited, for an installation of W.-D. continuous vertical retorts with a carbonising capacity of 308 tons per day. The installation will comprise twenty-eight 103-in. retorts, erected in a new steel-frame brick-built retort house, and will be complete with coal- and coke-handling plant, coke-screening and storage hoppers and waste-heat boilers. The Wellington (Salop) Gas Company have also placed an order with the Woodall-Duckham Company for an extension of four continuous vertical retorts to be built at the end of the existing bench.

Personal.

Mr. Charles Lyall Dalziel has been elected a director of Messrs. Dorman, Long & Company, Limited, Middlesbrough.

Mr. Sydney Evans, manufacturer of foundry equipment, 22-23, Laurence Pountney Lane, London, E.C.4, has now completely recovered from his recent serious illness, and has returned to business.

Mr. L. D. Whitehead has resigned his position as a director of the Ebbw Vale Steel, Iron and Coal Company, Limited. Mr. Whitehead is the chairman of the Whitehead Iron and Steel Company, Limited, and of Messrs. Whitehead, Hill & Company, Limited.

Mr. James Fraser, M.I.C.E., has intimated to the Inverness Harbour Trust his intention of retiring from the position of Harbour Engineer. Mr. Fraser, who is ninety years of age, has held the position for over sixty years, and has carried out a very great amount of harbour engineering in the Scottish Highlands.

Mr. Archibald Miller, who has been for more than forty years in the employ of the Woodside Ironworks, Coatbridge, celebrated his golden wedding on April 22. Mr. and Mrs. Miller were entertained by a number of friends, when an opportunity was taken of presenting the couple with a wallet of gold.

The Ministry of Labour has appointed ex-Provost J. M. Loudon, J.P., to be chairman of the Wishaw Employment Committee, in succession to Mr. E. H. Lewis, who is leaving the district. Ex-Provost Loudon has been a member of the committee since its inception, and has rendered invaluable service. At a meeting of the committee, held in the Employment Exchange, Wishaw, on April 23, Mr. Lewis, who has been chairman for the past nine years, was presented with a gold-mounted fountain-pen by his colleagues and officials.

On relinquishing the position of general manager of the Glasgow Iron and Steel Company, Limited, Mr. E. H. Lewis was entertained by the head-office staff and friends in the Grosvenor Restaurant. The new general manager, Mr. D. J. Barr, presided. Bailie Menzies, Bathgate, presented Mr. Lewis with a wallet of Treasury notes, and referred to his excellent work in the West of Scotland as president of the Iron and Steel Institute and in connection with the Wages Conciliation Board, etc. Mr. W. W. McCosh also spoke, and made reference to services rendered by Mr. Lewis to the various associations connected with the iron and steel trade in the West of Scotland.

In view of his approaching departure from the district to take up duties as director of the United Steel Companies, Limited, Workington, Mr. Robert Crichton, vice-chairman of the Scottish Iron and Steel Company, Limited, was entertained to lunch in the Conservative Club, Glasgow, by some of his colleagues and presented with an antique grandfather clock. The following evening he was again entertained to dinner by the members of the Manufactured Iron Trades Conciliation and Arbitration Board, in the Grosvenor Restaurant, Glasgow, when he was presented with his portrait in oil. This was the first occasion that employers and employee members of the Board had met in a social capacity.

Wills.

Hamilton, William, iron and steel merchant, of Glasgow £12,176

Barrow-Hope, J. B., of Messrs. J. Barrow-Hope & Company, Limited, iron and steel and tinplate merchants, Manchester £47,122

Redman, J. (62), of Cottesmore, Skircoat Green, Halifax, retired engineer and machine-tool maker, late of Messrs. C. Redman & Sons, Limited, of Pioneer Ironworks, Parkinson Lane, Halifax £55,908

Obituary.

Mr. William McCall, who died at Folkestone on Saturday, April 20, at the age of 78, was chairman of the Steel Barrel Company, Limited, of Uxbridge.

Mr. John Newton, chairman of Messrs. Billington & Newton, Limited, engineers and metal founders, Stoke-on-Trent, died on Friday, April 19, at the age of 86.

Mr. David Allison died suddenly at his home in Hyndland, Glasgow, on April 21. He was for many years with the Anderston Foundry Company, Limited, Glasgow.

Mr. George A. Williams, a director of Messrs. H. A. Watson & Company, Limited, metal brokers, Exchange Buildings, Liverpool, died at his residence in New Brighton on April 15.

The death is announced of Mr. John Morton Reid, at his residence in Motherwell, on April 17. Mr. Reid had been in the employ of Messrs. David Colville & Sons, Limited, Dalzell Iron and Steel Works.

Mr. Joseph Marsh, chairman of the Bradley Bar and Sheet Iron Company, Limited, Bilston, has died at the age of 83. Mr. Marsh was also at one time the owner of several collieries in Staffordshire.

Sir Aubrey Brocklebank, Bt., who died on Friday, April 19, in London, besides extensive business interests in the shipping industry, was a director of the Great Western Railway; William Hamilton & Company (1923), Limited, shipbuilders, of Port Glasgow; David Rowan & Company, Limited, engine builders, Glasgow; and the Narrow Gauge Railways, Limited, of Cumberland.

Contracts Open.

Cape Town, June 20.—One 10-ton and three 4-ton electrically-driven level luffing cranes, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7828.)

Durban, Natal, May 6.—10 miles of tram rails, complete with tiebars, fishplates and bolts, also special trackwork and rail bonds, for the Corporation of Durban, Natal. Messrs. Webster, Steel & Company, 36, Leadenhall Street, London, E.C.3. (Fee £2 2s., returnable.)

Johannesburg, May 30.—Wheels and axles, wheel centres and tyres, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7793.)

London, S.W., May 3 and 17.—Wheels and axles for carriages, and steel plates, channels, angles, trees, etc., for the Bombay, Baroda and Central India Railway Company, The White Mansion, 91, Petty France, Westminster, S.W.1. (Fee 10s., non-returnable.)

Stourbridge, May 23.—Triple-expansion vertical drop-valve engine directly connected with a set of vertical three-throw sewage-type ram pumps, for the Stourbridge Main Drainage Board. Mr. G. Plant Deeley, engineer, 13, Church Street, Stourbridge. (Fee £3 3s., returnable.)

Sydney, May 27.—One saddle-tank steam locomotive, for the Public Works Department of New South Wales. The Department of Overseas Trade. (Reference A.X. 7779.)

Warrington, May 6.—100 tons of steel tramway girder rails, two pairs of manganese points and two manganese crossings, for the Corporation. The Tramways Manager, Mersey Street, Warrington.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The situation of the Cleveland iron markets at the moment, as regards shortage of supplies, is perhaps without parallel in recent times, and, unless production can be immediately increased, there seem something like famine conditions facing consumers in the near future. Stocks of pig-iron, both in makers' and merchants' yards, are practically non-existent, as may be inferred from the fact that it is now extremely difficult to negotiate sales for delivery previous to July. As already noted in these columns, furnace owners are reluctant to place additional plant in commission owing to the excessive cost of production, confining attention in the meantime to their regular customers, whose needs must necessarily receive first consideration, but it will be unfortunate if opportunities of foreign trade, so long withheld, are now let slip owing to inability to execute orders from abroad. Thus, the position has arisen that all the current output of pig-iron has been sold. The minimum market rates are now as follow:—No. 1 Cleveland foundry iron, 71s.; No. 3 G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d.; No. 4 forge, 67s. per ton.

The position in the North-East Coast hematite market, which was recently tending to similar conditions to those in force in the foundry-pig section, has now been eased to some extent by an increase of furnace outputs on Tees-side, and production is now gradually overtaking demand. This movement has had the effect also of slightly easing prices, and, while sellers still quote 74s. for East Coast mixed numbers and 74s. 6d. per ton for No. 1 quality, there is manifested a greater willingness to shade these figures where a suitably large order is at stake. On the North-West Coast prices are steady, with Bessemer mixed numbers at 74s. per ton at works, low-phosphorus iron being 2s. 6d. to 5s. per ton dearer.

LANCASHIRE.—Price movements in local markets for pig-iron have undergone few variations of late, and buying on forward account has been exceptionally limited. A good many old contracts, however, are approaching the completion stage, and it is confidently expected that replacement orders will be more numerous before very long. Prices quoted here by Midland blast furnaces are maintained, and sellers appear to be quite confident that this position will continue. For local delivery current values are at 71s. per ton for Derbyshire makes and half-a-crown more for Staffordshire.

THE MIDLANDS.—At Birmingham this week markets for foundry pig were again quiet, and buying was on a restricted scale, being chiefly confined to prompt deliveries. There has, however, been a revision of the zone prices affecting North Staffordshire pig-iron, and these are now only 1s. per ton above the price for Derbyshire iron. The quotations are therefore 72s. 6d. for Derbyshire No. 3, 73s. 6d. for North Staffordshire and 69s. for Northamptonshire, delivered locally.

SCOTLAND.—Demand for foundry pig in this area is again of disappointing dimensions, local consumers being mostly still short of orders and export trade practically lifeless. Scotch pig-iron makers find that in many cases where consumers have bought ahead, they have evidently been rather optimistic, and find now that they are unable to take the iron out as quickly as they had expected. Prices are, however, firm, No. 3 foundry being quoted at 72s. 6d. and No. 1 quality at 75s. per ton.

Finished Iron.

With the scrap situation less difficult at the moment than it has been of late, Lancashire manufacturers of bar iron have taken no steps as yet to advance prices, although this course is regarded as inevitable if there is renewed stringency in scrap supplies. Inquiry in this section of the market continues on moderate lines, without any appreciable improvement in the tonnage being moved. Lancashire bars are at £10 10s. per ton for crown quality and 10s. per ton less for seconds. Merchant parcels of crown bars are offered on the basis of 14s. 6d. per cwt., less 2½ per cent., and including delivery to buyers' works.

Steel.

At Sheffield this week markets for steel and semi-products continue steady, the higher prices ruling for hard basic billets not having hindered business. Acid billets are quiet. A fair amount of business is being done in wire rods. All steel quotations remain unchanged. A rather better inquiry has developed for finished steel descriptions, but the overseas demand continues irregular. The principal support of the British works is still the shipyards, which are taking a considerable tonnage, and which have recently placed some fairly substantial orders. In the tinplate market prices continue steady, makers' quotations ruling as follow:—Coke tinplates, 18s. 6d. to 18s. 9d. basis for approved specifications, net cash, f.o.b. Welsh ports.

Scrap.

Demand for most qualities of foundry scrap material continues only moderate in volume, and on Tees-side consumers are still able to secure fair deliveries of ordinary heavy cast iron at 62s. 6d., but the supply is limited, and good machinery quality in handy pieces realises up to 66s. per ton. In the Midlands, although many of the local foundries say they are not exceptionally busy, there are good inquiries for heavy cast-iron machinery scrap at 70s. to 72s. 6d. delivered. Light cast-iron scrap is still scarce at 60s. delivered. In the Scottish markets all classes of cast-iron scrap are easier. For first-class machinery about 72s. 6d. or 73s. are the best prices that can be obtained, and for heavy ordinary cast iron 66s. 3d. to 67s. 6d. Old cast-iron railway chairs are around 68s. 6d., with light cast iron 65s. and cast-iron firebars at 63s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Although American advices have been more favourable of late, movements in warrant copper still indicate reserve on the part of buyers in the home market, and the tone generally is lacking in confidence of an early recovery. But, on the whole, the position has shown a steadier tendency, and values, which have fallen so rapidly, now would appear to have reached the lowest limit, although a definite reaction cannot be anticipated as yet.

Closing quotations are :—

Cash.—Thursday, £77 5s. to £77 10s.; Friday, £75 5s. to £75 10s.; Monday, £75 12s. 6d. to £75 15s.; Tuesday, £77 5s. to £77 10s.; Wednesday, £78 5s. to £78 10s.

Three Months.—Thursday, £74 5s. to £74 7s. 6d.; Friday, £73 2s. 6d. to £73 5s.; Monday, £72 12s. 6d. to £72 15s.; Tuesday, £73 to £73 5s.; Wednesday, £74 10s. to £74 15s.

Tin.—Standard tin values during the current week, though partially recovered from the recent heavy decline, remain irregular, due, it may be, to rumours of withdrawal of support from the group, hitherto practically commanding the position. As concerns supplies, shipments from Bolivia have tended to decline of late, but, apart from this, production is everywhere on the increase, while consumption is good, although, on account of the nervous tone in the market, buying has been on a very small scale of late.

Official closing prices :—

Cash.—Thursday, £201 5s. to £201 10s.; Friday, £196 5s. to £196 10s.; Monday, £198 12s. 6d. to £198 15s.; Tuesday, £198 to £198 5s.; Wednesday, £196 15s. to £196 17s. 6d.

Three Months.—Thursday, £203 to £203 5s.; Friday, £198 10s. to £198 12s. 6d.; Monday, £200 17s. 6d. to £201; Tuesday, £200 10s. to £200 15s.; Wednesday, £199 2s. 6d. to £199 7s. 6d.

Spelter.—The market for ordinary spelter has maintained a steady tendency of late, and values have shown only very small fluctuations. Consumers appear to be comfortably covered for the immediate future, while producers show no desire to press sales. On the whole, the market is rather dull, and what fluctuations there have been were chiefly due to developments in other markets.

Daily quotations are :—

Ordinary.—Thursday, £25 18s. 9d.; Friday, £26 10s.; Monday, £26 15s.; Tuesday, £26 15s.; Wednesday, £26 12s. 6d.

Lead.—Conditions in the market for soft foreign pig have now become more normal, and values have attained a more reasonable level. Buying for forward delivery has not been in evidence, and a return of confidence is anticipated now that the speculative holdings have been largely liquidated.

Prices have been :—

Soft Foreign Prompt.—Thursday, £24 10s.; Friday, £24 7s. 6d.; Monday, £24 10s.; Tuesday, £24 10s.; Wednesday, £24 8s. 9d.

Students' Corner

Q.—What are the desirable conditions for drying oil-sand-cores?

A.—To obtain the best results from the employment of any kind of core oil, or artificial binder, attention to baking time and temperature to suit that type of oil must be given. It must be borne in mind that an artificial binder with a linseed base, after the moisture is driven off, is a process of oxidation, in which atmospheric oxygen combines chemically with the oil and forms a film which is typical of paint work.

In the core oven, the process consists of evaporation of moisture, and provision for oxidation which will require a continuous and adequate flow of unburnt air through the oven.

1 lb. of linseed oil requires 1 lb. of oxygen, or 4½ lbs of air; 100 lbs. of green linseed-oil-cores would require 13½ lbs. of air, which would need to be heated to about 200 deg. C. With a preparation of an artificial binder with a linseed base, the above figures may be reduced to about one-half, due to a smaller proportion being used.

In a ton of oil-sand-cores containing 5 per cent. of moisture and 1 per cent. of oil, there is a cwt. of water to heat up to its boiling point—100 deg. C. This is due to the fact that air at all temperatures will hold a certain amount of water, the higher the temperature of the air to a certain point, the more moisture it can contain, but when that point, or limit, is passed, then the moisture falls in the form of a dew, i.e., a condensation, making everything dripping wet as it falls.

When the stove has reached a temperature of 100 deg. C., the cwt. of water in the ton of cores is rapidly evaporated. It requires, roughly, five and a-half times as much heat to evaporate the water in the cores, as it does to heat up the same amount of water from the cold state to boiling-point.

After the moisture is evaporated, the temperature of the stove rises rapidly, and if the cores were now removed from the stove they would be soft and sticky, they are now dried, but not baked. The physical change of evaporation has taken place, but the chemical change of oxidation has yet to be completed, which necessitates that the temperature be raised up to between 200 and 250 deg. C.

In good practice the oil, or artificial binder, is not completely oxidised, if that happens, then the cores would be extremely friable, and would fall to pieces, due to the bond being destroyed, and is parallel to burning the clay-bond from a natural-bonded-sand core. The oil binder should be nearly oxidised, then the resinous bodies are slightly charred, which will produce a core giving both strength and firmness, with a minimum of gas-content. Here the order when drying an oil-sand-core would be :—

(1) Heating-up with slight evaporation; (2) complete evaporation of moisture; (3) heating up the dried cores; (4) oxidation of the core oil; and (5) slight charring of the resinous substance.

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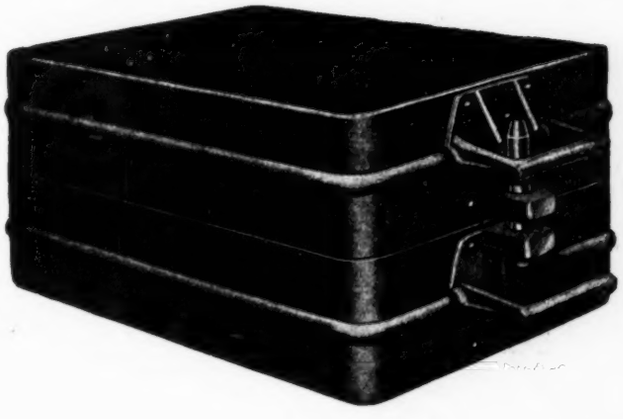

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COPPER.

	£	s.	d.
Standard cash	78	5	0
Three months	74	10	0
Electrolytic	83	0	0
Tough	77	15	0
Best selected	78	5	0
Sheets	112	0	0
India	98	0	0
Wire bars	84	0	0
Do. May	84	0	0
Do. June	84	0	0
Ingot bars	84	0	0
H.C. wire rods	86	0	0
Off. av. cash, April	81	2	7 11/24
Do. 3 mths., April	78	19	8 5/9
Do., Sttlmnt., April	81	2	8 2/9
Do., Electro, April	90	17	11 1/2
Do., B.S., April	85	16	11 1/2
Aver. spot price, copper, Apl.	81	2	7 11/24
Do. wire bars, April	92	7	10 5/8
Solid drawn tubes			15½d.
Brazed tubes			15½d.
Wire			12½d.

BRASS.

Solid drawn tubes	13d.
Brazed tubes	15d.
Rods, drawn	12½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	10¾d.
Yellow metal rods	8¼d.
Do. 4 × 4 Squares	9d.
Do. 4 × 3 Sheets	9½d.

TIN.

	£	s.	d.
Standard cash	196	15	0
Three months	199	2	6
English	199	0	0
Bars	201	0	0
Straits	199	10	0
Australian	199	0	0
Eastern	203	5	0
Banca	203	0	0
Off. av. cash, April	206	19	7 3/4
Do., 3 mths., April	208	1	5 3/4
Do., Sttlmt., April	207	0	0
Aver. spot, April	206	19	7 3/4

SPELTER.

	£	s.	d.
Ordinary	26	12	6
Remelted	25	10	0
Hard	21	10	0
Electro 99.9	29	12	6
English	27	5	0
India	23	5	0
Zinc dust	(Nom.) 36	10	0
Zinc ashes	9	0	0
Off. aver., April	26	13	8 3/4
Aver., spot, April	26	15	2 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	24	8	9
English	26	0	0
Off. average, April	24	11	10 5/8
Average spot, April	24	15	7 1/2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	34	10	0
Do. V.M. ex whf.	33	2	6
Rods	42	0	0
Boiler plates	31	0	0
Battery plates	32	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	54	10	0
Chinese	37	0	0
Crude	33	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	3	9

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	15	0
45/50%	12	0	0
75%	19	10	0
Ferro-vanadium—			
35/50%	13/6 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	3/9 lb. Mo.		
Ferro-titanium—			
23/25% carbonless	11d. lb.		
Ferro-phosphorus, 20/25%	£17	0	0
Ferro-tungsten—			
80/85%, c. fr.	2/10¼ lb.		
Tungsten metal powder—			
98/99%	3/0¼ lb.		
Ferro-chrome—			
2/4% car.	£33	0	0
4/6% car.	£24	17	6
6/8% car.	£23	0	0
8/10% car.	£22	15	0
Ferro-chrome—			
Max. 2% car.	£33	17	6
Max. 1% car.	£36	17	6
Max. 0·70% car.	£41	10	0
70% carbonless	1/2 lb.		
Nickel—99% cubes, or pellets	£175	0	0
Ferro-cobalt	9/4 lb.		
Aluminium 98/99%	£95	0	0
Metallic chromium—			
96/98%	2/4 lb.		
Ferro-manganese (net)—			
76/80% loose	£13	15	0
76/80% packed	£14	15	0
76/80%, export	£14	10	0
Metallic manganese—			
94/96%, carbonless	1/6 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	£	s.	d.
Finished bars, 14% tungsten	£0	2	0
Finshed bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	4	0	0	to	4	2	6
Bundled steel and shrngs	3	15	0	to	3	19	0
Mixed iron and steel					3	15	0
Heavy cast iron					3	7	6
Good machinery for foundries					3	10	0
Cleveland—							
Heavy steel					3	3	6
Steel turnings					2	18	6
Cast iron borings					2	15	0
Heavy forge					3	15	0
W.I. piling scrap					3	10	0
Cast-iron scrap	3	2	6	to	3	6	0
Lancashire—							
Cast-iron scrap	3	0	0	to	3	12	6
Hvy. wrought					3	15	0
Steel turnings	2	17	6	to	3	0	0
Scotland—							
Heavy steel					3	15	0
Cast-iron borings					2	15	0
Wrought-iron piling					3	12	6
Heavy machinery					3	13	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	64	0	0
Brass	43	0	0
Lead (less usual draft)	21	0	0
Tea lead	17	0	0
Zinc	18	0	0
New aluminium cuttings	67	0	0
Braziery copper	60	0	0
Gunmetal	55	0	0
Hollow pewter	160	0	0
Shaped black pewter	110	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	71/-
Foundry No. 3	68/6
Foundry No. 4	67/6
Forge No. 4	67/-
Hematite No. 1	74/6
Hematite M/Nos.	74/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	91/-
Midlands—	
Staffs. common*	—
,, No. 4 forge*	69/6
,, No. 3 fdry*	73/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	65/-
,, fdry. No. 3*	69/-
Derbyshire forge*	68/6
,, fdry. No. 3*	72/6
,, basic*	—

* d/d Black Country dist.

Scotland—	
Foundry No. 1	75/-
,, No. 3	72/6
Hem. M/Nos.	78/-
Sheffield (d/d district)—	
Derby forge	63/6
,, fdry. No. 3	67/6
Lincs. forge	67/6
,, fdry. No. 3	72/6
E.C. hematite	85/-
W.C. hematite	87/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	71/-
Northants foundry No. 3	—
Dalzell, No 3 (special)	102/6 to 105/-
Summerlee, No. 3	90/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	90/-
Monkland, No. 3	90/-
Shotts, No. 3	90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.		£	s.	d.
Iron—							
Bars (cr.) nom.					10	15	0
Nut and bolt iron	9	0	0	to	9	5	0
Hoops					11	10	0
Marked bars (Staffs.) f.o.t.					12	0	0
Gas strip					11	10	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	7	6	to	8	12	6
Boiler plts.					10	10	0
Chequer plts.					10	12	6
Angles					7	17	6
Tees					8	17	6
Joists					7	17	6
Rounds and squares, 3 in. to 5½ in.					8	17	6
Rounds under 3 in. to ¾ in. (Untested)					8	0	0

and upwards

	£	s.	d.
Flats, over 5 in. wide and up	8	7	6
Flats, 5 in. to 1½ in.	7	17	6
Rails, heavy	8	10	0
Fishplates	12	10	0
Hoops (Staffs.)	11	0	0
Black sheets, 24g.	10 0 0	to 10	10 0
Galv.cor.shts., 24g.	13 7 6	to 13	12 6
Galv. fencing wire 8g. plain	12	0	0
Billets, soft	6 7 6	to 7	0 0
Billets hard	7 10 0	to 8	2 6
Sheet bars	6 5 0	to 6	10 0
Tin bars	6 5 0	to 6	10 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6½
Rods	1/5
Tubes	1/9
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	15.50
Basic	19.76
Bessemer	20.79
Malleable	20.01
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.95
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'P'd, 9 and 10	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/- to 27/-
,, furnace	21/- to 23/-
Durham and North.	
,, foundry	16/- to 18/-
,, furnace	16/- to 16/6
Midlands, foundry	—
,, furnace	19/- and up

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/6
,,	28×20 ,,	36/6
,,	20×10 ,,	26/3
,,	18¾×14 ,,	18/9
C.W.	20×14 ,,	15/-
,,	28×20 ,,	33/6
,,	20×10 ,,	21/3
,,	18¾×14 ,,	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods, dead soft, steel	£10	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63¾%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
April	25 ..	77	5	0	dec.	5/-
„	26 ..	75	5	0	„	40/-
„	29 ..	75	12	6	inc.	7/6
„	30 ..	77	5	0	„	32/6
May	1 ..	78	5	0	„	20/-

Electrolytic Copper.

		£	s.	d.		
April	25 ..	83	15	0	dec.	5/-
„	26 ..	83	0	0	„	15/-
„	29 ..	83	0	0	No change	
„	30 ..	83	0	0	„	„
May	1 ..	83	0	0	„	„

Standard Tin (cash).

		£	s.	d.		
April	25 ..	201	5	0	dec.	42/6
„	26 ..	196	5	0	„	100/-
„	29 ..	198	12	6	inc.	47/6
„	30 ..	198	0	0	dec.	12/6
May	1 ..	196	15	0	„	25/-

Tin (English ingots).

		£	s.	d.		
April	25 ..	202	0	0	dec.	30/-
„	26 ..	197	0	0	„	100/-
„	29 ..	200	0	0	inc.	60/-
„	30 ..	199	0	0	dec.	20/-
May	1 ..	199	0	0	No change	

Zinc Sheets (English).

		£	s.	d.		
April	25 ..	34	5	0	No change	
„	26 ..	34	5	0	„	„
„	29 ..	34	5	0	„	„
„	30 ..	34	10	0	inc.	5/-
May	1 ..	34	10	0	No change	

Spelter (ordinary).

		£	s.	d.		
April	25 ..	25	18	9	dec.	7/6
„	26 ..	26	10	0	inc.	11/3
„	29 ..	26	15	0	„	5/-
„	30 ..	26	15	0	No change	
May	1 ..	26	12	6	dec.	2/6

Lead (English).

		£	s.	d.		
April	25 ..	26	0	0	dec.	5/-
„	26 ..	26	0	0	No change	
„	29 ..	26	0	0	„	„
„	30 ..	26	0	0	„	„
May	1 ..	26	0	0	„	„

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1888	44 4	42 3	42 1½	42 0	41 2½	42 1½	42 6½	44 0	45 8½	44 6	44 6	45 3½	43 4
1889	44 4	45 2	47 3½	48 9½	48 6½	48 7½	50 1½	53 11	55 3	63 6	73 10	73 2	54 4½
1890	76 1½	65 1	63 3	55 1	53 9½	50 11	52 3½	56 4	58 0	58 2	57 5	54 4½	58 5
1891	52 9	50 10	48 11	47 9½	51 5	50 6	50 10	48 4	50 1	49 1½	48 3½	47 8	49 8½
1892	47 4	45 6	46 4½	47 8	49 5	50 4½	49 7½	49 10½	48 8½	46 10	46 1½	48 2½	
1893	46 0½	45 8	45 11	45 7	44 11	44 9½	44 10	45 3	45 0	44 6	44 7	45 8	45 3
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 0½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1½
1923	100 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	—	—	—	—	—	—	—	—	—

* No prices available.

WILLIAM JACKS & COMPANY,
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18, BENNETTS HILL, BIRMINGHAM.

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(A remittance should accompany instructions.)

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FOUNDRY MANAGER desires position; 25 years' practical and technical training all classes engineering and jobbing work, in grey iron, semi-steel, iron alloys, and non-ferrous metals, mix by analysis, expert on cupola, get maximum production, guarantee results, take entire charge of foundry and pattern shop.—Box 186, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN PATTERN-MAKER WANTED; wood, lead and plaster; experience in gas-stove trade essential.—Write fully, stating experience, age, and salary required, also whether in employment, Sidney Flavel & Company, Limited, Leamington.

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PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—King's Patent Agency, Limited, 146a, Queen Victoria Street, E.C.4.

PROPERTY

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145,000 Sq. Ft. of SHOPPING,
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WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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ALBION WORKS, SHEFFIELD.

A TRAFFORD PARK BARGAIN.—Modern Foundry with own railway sidings, excellent warehouse, packing room and fine offices, centrally heated, for SALE. Premises are all one storey and easily adaptable for other trades. Cost £20,000 in 1921. For a quick sale, owners will take £2,000.—F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

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One 3-ton "Morris" Hand-operated Overhead Travelling Crane, Single-joist Type, Span 20 ft.

One 5-ton "Morris" Hand-operated Overhead Travelling Crane, Double-joist Type, Two Lifting Speeds, Gravity Lowering, Span 40 ft.

One 2-ton "Morris" Self-contained Radial Jib Crane with Barrel Standard; height Crane-hook to Floor, 11 ft. 6 in.; Radius about 14 ft. 6 in.

All for sale cheap. For further particulars and price write, Box 210, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

UNGER 8-in. x 32-in. Universal Grinding Machine, with internal attachment.

CENTAUR Vertical Keyseating Machine, 11¾-in. stroke.

REINECKER Automatic Spur Gear Cutting Machine, max. dia. gear 35½ in.

LANDIS 12-in. x 42-in. Plain Grinding Machine.

Two powerful WORM-GEARED STEAM WINCHES (Clarke Chapman), vert. engines, 10½ in. diameter x 10-in. stroke; drum 2 ft. 6 in. dia. x 4 ft. 7 in. wide.

STONE BREAKERS, 10 in. x 6 in. to 30 in. x 18 in. size, by Hadfields, Marsdens, Goodwin Barsby, etc.

Two LANCASHIRE BOILERS, 30 ft. 0 in. x 8 ft. 0 in., re-insure 110 lbs. pressure.

About 7,500 ft. of NEW 2-in. dia. screwed and socketed gas quality Piping, in lengths of about 18/21 ft.

About 28 secondhand Roof Principals, each about 64-ft. span x 15-ft. rise.

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THOS. W. WARD, LTD.,
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MINEOWNER, MATLOCK.

MISCELLANEOUS—*Continued.*

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CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. Buchanan & Company, Ashfield Road, Altrincham, Cheshire.

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'Phone: 287 SLOUGH

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15 Ton STEVENSON (as New)	£65
10 Ton EVANS (as New)	£48
8 Ton EVANS (as New)	£42
5 Ton EVANS (as New)	£35
4 Ton EVANS (as New)	£30
2 Ton JACKMAN (as New)	£24
1 Ton New (enclosed gear)	£19

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